ENVIRONMENTAL PROTECTION AGENCY

[EPA-HQ-OAR-2009-0211; FRL-XXXX-X]

Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy to Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator

AGENCY: Environmental Protection Agency

ACTION: Notice of Partial Waiver Decision

SUMMARY: The Environmental Protection Agency (EPA) is partially granting Growth Energy's waiver request application submitted under section 211(f)(4) of the Clean Air Act. This partial waiver allows fuel and fuel additive manufacturers to introduce into commerce gasoline that contains greater than 10 volume percent ethanol and no more than 15 volume percent ethanol (E15) for use in certain motor vehicles if certain conditions are fulfilled. We are partially approving the waiver for and allowing the introduction into commerce of E15 for use only in model year 2007 and newer light-duty motor vehicles, which includes passenger cars, light-duty trucks and medium-duty passenger vehicles. We are denying the waiver for introduction of E15 for use in model year 2000 and older light-duty motor vehicles, as well as all heavy-duty gasoline engines and vehicles, highway and off-highway motorcycles, and nonroad

engines, vehicles, and equipment. The Agency is deferring a decision on the applicability of a waiver to model year 2001 through 2006 light-duty motor vehicles until additional test data, currently under development, is available.

ADDRESSES: EPA has established a docket for this action under Docket ID No. EPA-HQ-OAR-2009-0211. All documents and public comments in the docket are listed on the www.regulations.gov website. Publicly available docket materials are available either electronically through www.regulations.gov or in hard copy at the Air and Radiation Docket in the EPA Headquarters Library, EPA West Building, Room 3334, 1301 Constitution Ave., N.W., Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding holidays. The telephone number for the Reading Room is (202) 566-1744. The Air and Radiation Docket and Information Center's Website is http://www.epa.gov/oar/docket.html. The electronic mail (e-mail) address for the Air and Radiation Docket is: a-and-r-Docket@epa.gov, the telephone number is (202) 566-1742 and the fax number is (202) 566-9744.

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I. Executive Summary

In March 2009, Growth Energy and 54 ethanol manufacturers petitioned the Environmental Protection Agency ("EPA" or "The Agency") to allow the introduction into commerce of up to 15 volume percent (vol%) ethanol in gasoline. In April 2009, EPA sought public comment on the Growth Energy petition and subsequently received about 78,000 comments. Prior to today's action, ethanol was limited to 10 vol% in motor vehicle gasoline (E10).

In today's action, EPA is partially granting Growth Energy's waiver request based on our careful analysis of the available information, including test data and public comments. This partial grant waives the prohibition on fuel and fuel additive manufacturers on the introduction into commerce of gasoline containing greater than 10 vol% ethanol and no more than 15 vol% ethanol (E15) for use in certain motor vehicles. More specifically, today's action has two components. First, we are approving the waiver for and allowing the introduction into commerce of E15 for use in Model Year (MY) 2007 and newer light-duty motor vehicles, which includes passenger cars, light-duty trucks, and medium-duty passenger vehicles[1]. Second, we are denying the waiver for introduction into commerce of E15 for use in MY2000 and older light-duty motor vehicles, as well as heavy-duty gasoline highway engines and vehicles (e.g., delivery trucks). Highway and off-highway motorcycles, and nonroad engines, vehicles, and equipment (nonroad products; e.g., boats, snowmobiles, and lawnmowers) typically use the same gasoline as highway motor vehicles; this decision is also a denial of a waiver for introducing motor vehicle gasoline into commerce containing more than 10 vol% ethanol for use in all of those products. The Agency is deferring a decision on the applicability of a waiver with respect to MY2001–2006 light-duty motor vehicles to await additional test data. The Department of Energy (DOE) has stated that it will complete testing on these vehicles in November, after which EPA will take appropriate action.

To help ensure that E15 is only used in MY2007 and newer light-duty motor vehicles, EPA has developed a proposed rule (described below) with the express purpose of mitigating the potential for misfueling of E15 into vehicles and engines not approved for its use. EPA believes the proposed safeguards against misfueling would provide the most practical way to mitigate the potential for misfueling with E15. Moreover, the proposed rule, when adopted, would satisfy the misfueling mitigation conditions of today's partial waiver described below and would promote the successful introduction of E15 into commerce. However, if parties covered by this waiver (fuel and fuel additive manufacturers, which include renewable fuel producers and importers, petroleum refiners and importers, and ethanol blenders) desire to introduce E15 into commerce prior to a final rule being issued, they may do so provided they submit and EPA approves a plan

[1] For purposes of today's decision, "MY2007 and newer light-duty motor vehicles" include MY2007 and newer light-duty motor vehicles (LDV), light-duty trucks (LDT), and medium-duty passenger vehicles (MDPV).

that demonstrates that the misfueling mitigation conditions will be satisfied. In addition to the misfueling mitigation conditions, E15 must also meet certain fuel quality specifications before it may be introduced into commerce.

To receive a waiver, as prescribed by the Clean Air Act, a fuel or fuel additive manufacturer must demonstrate that a new fuel or fuel additive will not cause or contribute to the failure of an engine or vehicle to achieve compliance with the emission standards to which it has been certified over its useful life. Reflecting that EPA's emission standards have continued to evolve and become more stringent over time, the in-use fleet is composed of vehicles and engines spanning not only different technologies, but also different emissions standards. Since ethanol affects different aspects of emissions, a wide range of data and information covering a wide range of highway and nonroad vehicles, engines, and equipment would be necessary for approval of an E15 waiver that would allow E15 to be introduced into commerce for use in all motor vehicles and all other engines and vehicles using motor vehicle gasoline ("full waiver"). Growth Energy failed to provide the necessary information to support a full waiver in several key areas, especially long-term durability emissions data necessary to ensure that all motor vehicles, heavy-duty gasoline highway engines and vehicles, highway and off-highway motorcycles and nonroad products would continue to comply with their emission standards over their full useful life. In 2008, DOE began emissions durability testing on 19 Tier 2 motor vehicle models that would provide this data for MY2007 and newer light-duty motor vehicles ("DOE Catalyst Study").[2] Consequently, the Agency delayed a decision until the DOE test program was completed for these motor vehicles in September 2010.

[2] DOE embarked on the study, in consultation with EPA, auto manufacturers, fuel providers and others, after enactment of the Energy Independence and Security Act of 2007, which significantly expanded the federal

EPA reached its decision on the waiver request based on the results of the DOE Catalyst Study and other information and test data submitted by Growth Energy and in public comments. EPA also applied engineering judgment, based on the data in reaching its decision. Specifically, consistent with past waiver decisions, the Agency evaluated Growth Energy's waiver request and made its decision based on four factors: (1) exhaust emissions impacts – long-term (known as durability) and immediate; (2) evaporative system impacts – both immediate and long-term; (3) the impact of materials compatibility on emissions; and, (4) the impact of drivability and operability on emissions. The Agency's conclusions are summarized below and additional information on each subject is provided later in this decision document.

MY2007 and Newer Light-duty Motor Vehicles

For MY2007 and newer light-duty motor vehicles, the DOE Catalyst Study and other information before EPA adequately demonstrates that the impact of E15 on overall emissions, including both immediate[3] and durability related emissions, will not cause or contribute to violations of the emissions standards for these motor vehicles. Likewise, the data and information adequately show that E15 will not lead to violations of the evaporative emissions standards, so long as the fuel does not exceed a Reid Vapor Pressure (RVP) of 9.0 psi in the

Renewable Fuel Standard Program for increasing the use of renewable fuels in transportation fuel in order to reduce imported petroleum and emissions of greenhouse gases.

[3] In past waiver decisions, we have referred to "immediate" emissions as "instantaneous" emissions. "Immediate" and "instantaneous" are synonymous in this context.

summertime control season.[4] The information on materials compatibility and drivability also supports this conclusion.

Durability/Long-term Exhaust Emissions

The DOE Catalyst Study involved 19 high sales volume car and light-duty truck models (MY2005-2009 motor vehicles produced by the top U.S. sales-based automobile manufacturers) that are all designed for and subject to the Tier 2 motor vehicle emission standards. The purpose of the program was to evaluate the long term effects of E0 (gasoline that contains no ethanol and is the certification test fuel for emissions testing), E10, E15, and E20 (a gasoline-ethanol blend containing 20 vol% ethanol) on the durability of the exhaust emissions control system, especially the catalytic converter (catalyst), for Tier 2 motor vehicles. Analysis of the motor vehicles' emissions results at full useful life (120,000 miles) and emissions deterioration rates showed no significant difference between the E0 and E15 fueled groups. Three motor vehicles aged on EO fuel had failing emissions levels and one additional motor vehicle failed one of several replicate tests. One E15-aged motor vehicle had failing emissions.[5] However, none of the emissions failures appeared to be related to the fuel used. There were no emissions component or material failures during aging that were related to fueling. In addition, a review of the emission deterioration rates over the course of the test program revealed no statistically significant difference in emissions deterioration with E15 in comparison to E0. Using standard statistical

[4] EPA regulates the vapor pressure of gasoline sold at retail stations during the summer ozone season (June 1 to September 15) to reduce evaporative emissions from gasoline that contribute to ground-level ozone and diminish the effects of ozone-related health problems. Gasoline needs a higher vapor pressure in the wintertime for cold start purposes.

[5] It should be noted that the Dodge Caliber vehicle aged on E15 failed Tier 2 Bin 5 FUL standards on E0. However, this vehicle met Tier 2 Bin 5 FUL standards when tested on E15. The Agency could not determine the cause.

tools, the test results support the conclusion that E15 does not cause or contribute to the failure of MY2007 and newer light-duty motor vehicles in achieving their emissions standards over their useful lives. These results confirm EPA's engineering assessment that the changes manufacturers made to their motor vehicles (calibration, hardware, etc.) to comply with the Agency's stringent Tier 2 emission standards (which began to phase in with MY2004) have resulted in the capability of Tier 2 motor vehicles to accommodate the additional enleanment caused by E15 and be compatible with ethanol concentrations up to E15[6]. EPA's certification data show that all gasoline-fueled cars and light-duty trucks were fully phased in to the Tier 2 standards by MY2007 even though the program did not require the phase-in to be complete until MY2009. Consequently, EPA believes it appropriate to apply these test results to all MY2007 and newer light-duty motor vehicles.

Immediate Exhaust Emissions

Scientific information supports a conclusion that motor vehicles experience an immediate emissions impact independent of motor vehicle age (and therefore emission control technology) when operating on gasoline-ethanol blends. Nitrogen oxide (NOx) emissions generally increase while volatile organic compound (VOC) and carbon monoxide (CO) emissions decrease. The available data supports a conclusion that the immediate emissions impacts of E15 on Tier 2 motor vehicles are likely to have the same pattern as the immediate emissions impacts of E10 on older motor vehicles (i.e., NOx emissions increase while VOC and CO emissions decrease). Although the magnitude of the immediate impact is expected to be slightly greater with E15, Tier 2 motor vehicles generally have a significant compliance margin at the time of certification and

[6] *See* 65 FR 6698 (February 10, 2000).

later on in-use (when they are in customer service) that should allow them to meet their emission standards even if they experience the predicted immediate NOx increases from E15 when compared to E0. The results of the DOE Catalyst Study reflect both the immediate emissions effects as well as any durability effects as described above, and the Tier 2 motor vehicles continued to comply with their emissions standards at their full useful life. As noted above, none of the emissions failures appeared to be related to the fuel used. Based on this immediate exhaust emissions information, coupled with the durability test data and conclusions, E15 is not expected to cause Tier 2 motor vehicles to exceed their exhaust standards over their useful lives when operated on E15.

Evaporative Emissions

Both diurnal and running loss evaporative emissions increase as fuel volatility increases. Diurnal evaporative emissions occur when motor vehicles are not operating and experience the change in temperature during the day, such as while parked. Running loss evaporative emissions occur while motor vehicles are being operated. Reid Vapor Pressure (RVP) is the common measure of the volatility of gasoline. E15 that meets an RVP limit of 9.0 pounds per square inch (psi) during the summer (which is equal to the RVP of E0) should not produce higher diurnal or running loss evaporative emissions than E0. We expect MY2007 and newer vehicles to meet evaporative emissions standard on 9.0 psi E15. There are concerns with E15 having an RVP greater than 9.0 psi. When ethanol is blended at 15 vol%, a 10.0 psi RVP fuel compared to 9.0 psi RVP fuel will have substantially higher evaporative emissions levels that must be captured by the emissions control system (a carbon filled canister and related system elements). This increase in evaporative emissions is beyond what manufacturers have been required to control, based on the motor vehicle certification testing for the emissions standards. Test results highlight the concern that fuel with an RVP greater than 9.0 psi during the summer will lead to motor vehicles exceeding their evaporative emission standards in-use. Additionally, as explained in the misfueling mitigation measures proposed rule, EPA interprets the 1.0 psi waiver in CAA section 211(h) as being limited to gasoline-ethanol blends that contain 10 vol% ethanol. Therefore, given the significant potential for increased evaporative emissions at higher gasoline volatility levels, and the lack of data to resolve how this would impact compliance with the emissions standards, today's waiver is limited to E15 with a summertime RVP no higher than 9.0 psi.

Other potential issues for evaporative emissions of motor vehicles operated on E15 are increased permeation and long-term (durability) impacts.[7] Available test data indicate that for Tier 2 motor vehicles any increase in evaporative emissions as a result of permeation is limited and within the evaporative compliance margins for these motor vehicles. This is consistent with the demonstration of evaporative emissions system durability after aging on E10 that was required beginning with the Tier 2 motor vehicle standards, for the purpose of limiting permeation. With respect to durability of the evaporative emissions control systems, data from several aspects of the DOE Catalyst Study point to the expected durability of the evaporative emissions control system of Tier 2 motor vehicles on E15. First, there appears to be no evidence of an increase in evaporative emissions system onboard diagnostic system codes being triggered by E15 compared to E0. Second, teardown results of the 12 motor vehicles tested (six models

[7] Permeation refers to the migration of fuel molecules through the walls of elastomers used for fuel system components.

with E0 and six models with E15) found no abnormalities for E15 motor vehicles compared to E0 motor vehicles.[8] Finally, evaporative testing on four of the Tier 2 motor vehicles over the course of the test program found no increased deterioration in evaporative emissions with E15 in comparison to E0.[9] Therefore, after taking into account all of these sources of evaporative emissions data, the evidence supports a conclusion that as long as E15 meets a summertime control season gasoline volatility level of no higher than 9.0 psi, E15 is not expected to cause or contribute to exceedances of the evaporative emission standards over the full useful life of Tier 2 motor vehicles.

Materials Compatibility

Materials compatibility is a key factor in considering a fuel or fuel additive waiver insofar as poor materials compatibility can lead to serious exhaust and evaporative emission compliance problems not only immediately upon use of the new fuel or fuel additive, but especially over the full useful life of vehicles and engines. As part of its E15 waiver application, Growth Energy submitted a series of studies completed by the State of Minnesota and the Renewable Fuels Association (RFA) that investigated materials compatibility of motor vehicle engines and engine components using three test fuels: E0, E10, and E20. The materials studied included what were considered to be many of the common metals, elastomers, and plastics used in motor vehicle fuel systems. Growth Energy concluded that E15 would not be problematic for current automotive or fuel dispensing equipment. While directionally illustrative, the materials

[8] Southwest Research Institute Project 08-58845 Status Report, "Powertrain Component Inspection from Mid-Level Blends Vehicle Aging Study," September 6, 2010. *See* EPA-HQ-OAR-2009-0211-14016.
[9] Environmental Testing Corporation NREL Subcontract JGC-9-99141-01 Presentation, "Vehicle Aging and Comparative Emissions testing Using E0 and E15 Fuels: Evaporative Emissions Results," August 31, 2010. *See* EPA-HQ-OAR-2009-0211-14015.

compatibility information submitted by Growth Energy does not encompass all materials used in motor vehicle fuel systems, and the test procedures used are not representative of the dynamic real-world conditions under which the materials must perform. The information is therefore insufficient by itself to adequately assess the potential material compatibility of E15. However, the information generated through the DOE Catalyst Study demonstrates that MY2007 and newer light-duty motor vehicles will not experience materials compatibility issues that lead to exhaust or evaporative emission exceedances. The DOE Catalyst Study supports the Agency's engineering assessment that newer motor vehicles such as those subject to EPA's Tier 2 standards, were designed to encounter more regular ethanol exposure compared to earlier model year motor vehicles. Other regulatory requirements also placed an emphasis on real world motor vehicle testing, which in turn prompted manufacturers to consider different available fuels when developing and testing their emissions systems. Additionally, beginning with Tier 2, the evaporative durability demonstration procedures required the use of E10. As a result, based on the information before us, we do not expect E15 to raise emissions related materials compatibility issues for Tier 2 motor vehicles.

Drivability and Operability

There is no evidence from any of the test programs cited by Growth Energy or in the data from the DOE Catalyst Study of driveability issues for Tier 2 motor vehicles fueled with E15 that would indicate that use of E15 would lead to increased emissions or that might cause motor vehicle owners to want to tamper with the emission control system of their motor vehicle. The Agency reviewed the data and reports from the different test programs, and found no specific report of driveability or operability issues across the many different motor vehicles and duty cycles, including lab testing and in-use operation.

MY2000 and Older Light-duty Motor Vehicles

For MY2000 and older motor vehicles, the data and information before EPA fail to adequately demonstrate that the impact of E15 on exhaust emissions – both immediate and durability-related – will not cause or contribute to violations of the emissions standards for these motor vehicles. MY2000 and older motor vehicles do not have the sophisticated emissions control systems of today's Tier 2 motor vehicles, and there is an engineering basis to believe they may experience conditions affecting catalyst durability that lead to emission increases if operated on E15. This emissions impact, over time, combined with the expected immediate increase in NOx emissions from the use of E15, provides a clear basis for concern that E15 could cause these motor vehicles to exceed their emissions standards over their useful lives. Furthermore, some MY2000 and older motor vehicles were likely designed for no more than limited exposure to ethanol, since gasoline-ethanol blends were not used in most areas of the country at the time they were designed. Their fuel systems, evaporative emissions control systems, and internal engine components may not have been designed and tested for long-term durability, materials compatibility, or drivability with fuels containing ethanol. The limited exhaust emissions durability test data, evaporative emissions durability test data, and real-world materials compatibility test data either provided by Growth Energy in their petition or available in the public domain do not address or resolve these concerns. Therefore, the information before the Agency is not adequate to make the demonstration needed to grant a waiver for the introduction into commerce of E15 for use in MY2000 and older light-duty motor vehicles.

MY2001-2006 Light-duty Motor Vehicles

EPA is deferring a decision on MY2001-2006 light-duty motor vehicles. DOE is in the process of conducting additional catalyst durability testing that will provide data regarding MY2001-2006 motor vehicles. The DOE testing is scheduled to be completed by the end of November 2010. EPA will make the DOE test results available to the public and consider the results and other available data and information in making a determination on the introduction into commerce of E15 for use in those model year motor vehicles. EPA expects to make a determination for these motor vehicles shortly after the results of DOE testing are available.

Nonroad Engines, Vehicles, and Equipment (Nonroad Products)

The nonroad product market is extremely diverse. Nonroad products with gasoline engines include lawn mowers, chainsaws, forklifts, boats, personal watercraft, and all-terrain vehicles. Growth Energy did not provide information needed to broadly assess the potential impact of E15 on compliance of nonroad products with applicable emissions standards. Nonroad products typically have more basic engine designs, fuel systems, and controls than light-duty motor vehicles. The Agency has reasons for concern with the use of E15 in nonroad products, particularly with respect to long-term exhaust and evaporative emissions durability and materials compatibility. The limited information provided by Growth Energy and commenters, or otherwise available in the public domain, did not alleviate these concerns. As such, the Agency cannot grant a waiver for introduction into commerce of E15 motor vehicle gasoline that is also for use in nonroad products.

Heavy-duty Gasoline Engines and Vehicles

Given their relatively small volume compared to light-duty motor vehicles, heavy-duty gasoline engines and vehicles have not been the focus of test programs and efforts to assess the potential impacts of E15 on them. Growth Energy did not provide any data specifically addressing how heavy-duty gasoline engines' and vehicles' emissions and emissions control systems would be affected by the use of E15 over the full useful lives of these vehicles and engines. Additionally, from a historical perspective, the introduction of heavy-duty gasoline engine and vehicle technology has lagged behind the implementation of similar technology for light-duty motor vehicles. Similarly, emission standards for this sector have lagged behind those of light-duty motor vehicles, such that current heavy-duty gasoline engine standards remain comparable, from a technology standpoint to older light-duty motor vehicle standards. Consequently, we believe the concerns expressed above regarding MY2000 and older motor vehicles are also applicable to the majority of the in-use fleet of heavy-duty gasoline engines and vehicles. As such, the Agency cannot grant a waiver for the introduction into commerce of E15 for use in heavy-duty gasoline engines and motor vehicles.

Highway and Off-Highway Motorcycles

Like heavy-duty gasoline engines and vehicles, highway and off-highway motorcycles have not been the focus of E15 test programs. Growth Energy did not provide any data addressing how motorcycle emissions and emissions control systems would specifically be affected by the use of E15 over their full useful lives. While newer motorcycles incorporate some of the advanced fuel system and emission control technologies that are found in passenger cars and light-duty trucks, such as electronic fuel injection and catalysts, many do not have the specific control technology of today's motor vehicles (advanced fuel trim control) that would allow them to adjust to the higher oxygen content of E15. More importantly, older motorcycles do not have any of these technologies and are therefore more on par with nonroad products in some cases and MY2000 and older motor vehicles in others. As such, the Agency cannot grant a waiver for the introduction into commerce of E15 for use in highway and off-highway motorcycles.

Conditions on Today's Partial Waiver

There are two types of conditions being placed on the partial waiver being granted today: those for mitigating the potential for misfueling of E15 in all vehicles, engines and equipment for which E15 is not approved, and those addressing fuel and ethanol quality. All of the conditions are discussed further below and are listed in Section XII.

EPA believes that the misfueling mitigation measures in the proposed rule accompanying today's waiver decision would provide the most practical way to ensure that E15 is only used in vehicles for which it is approved. However, if any fuel or fuel additive manufacturer desires to introduce into commerce E15, gasoline intended for use as E15, or ethanol intended for blending with gasoline to create E15, prior to the misfueling mitigation measures rule becoming final and effective, they may do so provided they implement all of the conditions of the partial waiver, including an EPA-approved plan that demonstrates that the fuel or fuel additive manufacturer will implement the misfueling mitigation conditions discussed below.

Misfueling Mitigation Notice of Proposed Rulemaking (NPRM)

As mentioned above, EPA is proposing a regulatory program that would help mitigate the potential for misfueling with E15 and promote the successful introduction of E15 into commerce. The proposal includes several provisions that parallel the misfueling mitigation conditions on the E15 waiver. First, the proposed rule would prohibit the use of gasoline-ethanol blended fuels containing greater than 10 vol% and up to 15 vol% ethanol in vehicles and engines not covered by the partial waiver for E15. Second, the proposed rule would require all fuel dispensers to have a label if a retail station chooses to sell E15, and it seeks comment on separate labeling requirements for blender pumps and fuel pumps that dispense E85. Finally, the proposed rule would require product transfer documents (PTDs) specifying ethanol content and RVP to accompany the transfer of gasoline blended with ethanol as well as a national survey of retail stations to ensure compliance with the these requirements. In addition to proposing actions to mitigate misfueling, the proposed rule would modify the Reformulated Gasoline ("RFG") program by updating the Complex Model to allow fuel manufacturers to certify batches of gasoline containing up to 15 vol% ethanol. Once adopted, these regulations would facilitate the introduction of E15 into commerce under this partial waiver, as certain requirements in the regulations would satisfy certain conditions in the waiver. If EPA adopts such a rule, EPA would consider any appropriate modifications to the conditions of this waiver.

II. Introduction

A. Statutory Background

Section 211(f)(1) of the Clean Air Act ("CAA" or "the Act") makes it unlawful for any manufacturer of any fuel or fuel additive to first introduce into commerce, or to increase the concentration in use of, any fuel or fuel additive for use by any person in motor vehicles manufactured after model year 1974 which is not substantially similar to any fuel or fuel additive utilized in the certification of any model year 1975, or subsequent model year, vehicle or engine under section 206 of the Act. The Environmental Protection Agency ("EPA" or "the Agency") last issued an interpretive rule on the phrase "substantially similar" at 73 FR 22281 (April 25, 2008). Generally speaking, this interpretive rule describes the types of unleaded gasoline that are likely to be considered "substantially similar" to the unleaded gasoline utilized in EPA's certification program by placing limits on a gasoline's chemical composition as well as its physical properties, including the amount of alcohols and ethers (oxygenates) that may be added to gasoline. Fuels that are found to be "substantially similar" to EPA's certification fuels may be registered and introduced into commerce. The current "substantially similar'' interpretive rule for unleaded gasoline allows oxygen content up to 2.7% by weight for certain ethers and alcohols.[10] E10 (a gasoline-ethanol blend containing 10 vol% ethanol) contains approximately 3.5% oxygen by weight and received a waiver of this prohibition by operation of law under section 211(f)(4).[11] E15 (gasoline-ethanol blended fuels containing greater than 10 vol% ethanol and up to 15 vol% ethanol) has greater than 2.7 wt% oxygen content, and Growth Energy has applied for a waiver under section 211(f)(4) of the Act.

Section 211(f)(4) of the Act provides that upon application of any fuel or fuel additive manufacturer, the Administrator may waive the prohibitions of section 211(f)(1) if the Administrator determines that the applicant has established that such fuel or fuel additive, or a specified concentration thereof, will not cause or contribute to a failure of any emission control device or system (over the useful life of the motor vehicle, motor vehicle engine, nonroad engine or nonroad vehicle in which such device or system is used) to achieve compliance by the vehicle or engine with the emission standards to which it has been certified pursuant to sections 206 and 213(a). In other words, the Administrator may grant a waiver for a prohibited fuel or fuel additive if the applicant can demonstrate that the new fuel or fuel additive will not cause or contribute to engines, vehicles or equipment to fail to meet their emissions standards over their useful lives. The statute requires that the Administrator shall take final action to grant or deny the application, after public notice and comment, within 270 days of receipt of the application.

The current section 211(f)(4) reflects the following changes made by the Energy Independence and Security Act of 2007: (1) requires consideration of the impact on nonroad

[10] *See* 56 FR 5352 (February 11, 1991).
[11] As explained at 44 FR 20777 (April 6, 1979), EPA did not grant or deny a waiver request for a fuel containing 90% unleaded gasoline and 10% ethyl alcohol within 180 days of receiving that request. By operation of a provision that was at that time included in section 211(f)(4), E10 was no longer subject to the prohibitions in CAA section 211(f)(1) of the Act. That provision has subsequently been removed.

engines and nonroad vehicles in a waiver decision; (2) extends the period allowed for consideration of the waiver request application from 180 days to 270 days; and, (3) deletes a provision that resulted in a waiver request becoming effective by operation of law if the Administrator made no decision on the application within 180 days of receipt of the application.[12]

B. Growth Energy Application and Review Process

On March 6, 2009, Growth Energy and 54 ethanol manufacturers (hereafter "Growth Energy") submitted an application to the U.S. Environmental Protection Agency (EPA) for a waiver of the substantially similar prohibition. This application seeks a waiver for gasoline containing up to 15 vol% ethanol. On April 21, 2009, EPA published notice of the receipt of the application, and EPA requested public comment on all aspects of the waiver application for assisting the Administrator in determining whether the statutory basis for granting the waiver request for E15 has been met.[13] EPA originally provided a 30-day period for the public to respond. The deadline for public comment was May 21, 2009.

After multiple requests for additional time to comment, EPA agreed that additional time for comments was appropriate and that an extension of the comment period would aid in providing these stakeholders and others an adequate amount of time to respond to the complex legal and technical issues that result from possibly allowing E15 to be sold commercially. Accordingly, on May 20, 2009, EPA published a Federal Register notice extending the public

[12] As noted previously, the Energy Independence and Security Act of 2007 also substantially increased the mandated renewable fuel requirements of the Renewable Fuels Standard Program.
[13] *See* 74 FR 18228 (April 21, 2009).

comment period for the E15 waiver application until July 20, 2009.[14] For EPA's response to more recent requests for an additional comment period, see section IX.

The Agency received approximately 78,000 comments on the waiver application. The overwhelming majority of these comments were brief comments from individuals indicating either general support for or opposition to the E15 waiver application. The Agency also received a large number of comments from a variety of organizations which substantively addressed the questions which EPA posed in the Federal Register notice announcing receipt of the application. These comments are summarized and addressed below.

In addition to the information submitted by Growth Energy and commenters, the Department of Energy (DOE) has been performing, and continues to perform, testing on a variety of motor vehicles focused on the effect E15 might have on motor vehicles after long-term use of E15 ("DOE Catalyst Study"). This testing is a significant source of information on the effects of E15 on the durability of motor vehicles' emissions control systems, a key technical issue to be addressed in EPA's waiver review. This kind of testing requires thousands of miles of mileage accumulation (or its equivalent using a test cell), and the collection of such data requires a significant amount of time to complete.

Coordinating with EPA and stakeholders, DOE expedited the durability testing, first focusing on newer motor vehicles. Realizing that it would take a significant amount of time (months) to finish collecting and evaluating the durability data, EPA notified Growth Energy in a letter on November 30, 2009, that it was not issuing a decision on the waiver at that time but

[14] *See* 74 FR 23704 (May 20, 2009).

instead planned to issue a decision at a later date based on the need to assess the critical data being generated by the DOE catalyst durability test program.

The DOE Catalyst Study is comprehensive. A total of 82 vehicles are expected to undergo full useful life testing. Motor vehicles are accumulating mileage under an accelerated protocol, which generally results in each motor vehicle being tested over 6-9 months. DOE has completed the first phase of this testing which focused on light-duty motor vehicles certified to federal Tier 2 emissions standards. The analysis and evaluation of not only this durability data, but all of the data relevant to the Growth Energy application, as well as EPA's partial waiver decision, is discussed and explained below. DOE should complete testing on vehicles certified to National Low Emission Vehicle (NLEV) and Tier 1 federal emission standards by the end of November.

Various parties have also suggested allowances for the use of E12 (gasoline-ethanol blended fuel that contains 12 vol% ethanol) for all gasoline-powered vehicles and engines. The issue of E12 is also discussed separately below in Section VIII.

C. Today's Notice of Proposed Rulemaking (NPRM) on Misfueling Mitigation Measures

As noted above, today's partial waiver decision places several conditions on fuel and fuel additive manufacturers to mitigate the use of E15 in nonroad products, highway and off-highway motorcycles, heavy duty gasoline engines and vehicles, and motor vehicles older than MY2007.[15]

In a separate notice, we are today proposing regulatory provisions that parallel many of the conditions placed on the E15 partial waiver. Specifically, we are proposing a prohibition on the use of gasoline containing greater than 10 vol% ethanol in MY2000 and older non-flex fueled light-duty motor vehicles, heavy-duty gasoline engines and vehicles, highway and off-highway motorcycles, and all nonroad products, based on findings under both sections 211(c)(1)(A) and (B) of the CAA. The prohibition is necessary based on the potential for increased emissions resulting from the use of E15. In order to facilitate the entry of E15 into commerce for use in MY2007 and newer motor vehicles, while protecting vehicles and engines not approved for use of E15, this rulemaking proposes fuel pump labeling provisions to mitigate the misfueling of motor vehicles and other engines, vehicles and equipment prohibited from using a motor vehicle gasoline containing ethanol in levels higher than E10. We are also proposing additional requirements for fuels that contain greater than 10 vol% ethanol and no more than 15 vol% ethanol, including the proper documentation of ethanol content on product transfer documents and requirements for a national survey to ensure the proper placement of E15 labels and the proper placement of gasoline-ethanol blends in the appropriate gasoline storage tanks; these provisions should help support the effectiveness of a labeling program.

III. Method of Review

[16] "Waiver Requests under Section 211(f) of the Clean Air Act (Revised August 22, 1995)", found at http://www.epa.gov/otaq/regs/fuels/additive/waiver.pdf.

Under section 211(f)(4) of the Act, 24 applications for waivers of the section 211(f)(1) prohibitions have been received over the past 30 years. Of these, 23 applications have sought a waiver for additives for unleaded gasoline. One application sought a waiver of the section 211(f)(1)(B) prohibitions for an additive to diesel fuel. Of these 24 applications, 11 applications were granted (some with conditions attached), 10 were denied, and three were withdrawn by the applicant prior to the Agency's decision.[16]

Section 211(f)(4) clearly places upon the waiver applicant the burden of establishing that its fuel or fuel additive will not cause or contribute to the failure of vehicles or engines to meet their assigned emission standards over their useful lives. Absent a sufficient showing, the Administrator cannot make the required determination and cannot grant the waiver. If interpreted literally, however, this burden of proof would be virtually impossible for an applicant to meet as it requires the proof of a negative proposition: that no vehicle or engine will fail to meet emission standards to which it has been certified. Such a literal interpretation could be construed as requiring the testing of every vehicle or engine that will use the waived fuel. Recognizing that Congress contemplated a workable waiver provision, EPA has previously indicated that reliable statistical sampling and fleet testing protocols could safely be used to demonstrate that a fuel or fuel additive under consideration would not cause or contribute to motor vehicles in the applicable national fleet failing to meet their applicable emissions standards.[17]

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[16] "Waiver Requests under Section 211(f) of the Clean Air Act (Revised August 22, 1995)", found at http://www.epa.gov/otaq/regs/fuels/additive/waiver.pdf.
[17] *See* 43 FR 41425 (September 18, 1978).

While this demonstration typically takes the form of reliable statistical sampling and fleet testing protocols, an applicant may also make a demonstration based upon a reasonable theory regarding emissions effects and support these judgments with confirmatory testing as an alternative to providing the amount of data necessary to conduct robust statistical analyses.[18] If a reasonable theory exists, based on good engineering judgment, which predicts the emission effects of a fuel or fuel additive, an applicant may only need to conduct a sufficient amount of testing to demonstrate the validity of such a theory. This theory and confirmatory testing then form the basis from which the Administrator may exercise his or her judgment on whether the fuel or fuel additive will cause or contribute to a failure of the vehicles and engines to achieve compliance with their emission standards.[19] Thus, the burden of proof calls for sufficient data to conduct statistical analyses or to confirm a reasonable theory based on sound engineering judgment.

In determining whether a waiver applicant has established that the proposed fuel or fuel additive will not cause or contribute to vehicles and engines failing to meet their emission standards, EPA reviews all of the material in the public docket. At a minimum, the docket includes data submitted with the application and the public comments and data received during the public review and comment period on the application. EPA may also examine applicable data from any other sources which may shed light on the relevant analyses; such other data is also placed in the docket. EPA then considers and analyzes all of the data to ascertain the emission effects of the fuel or fuel additive on the applicable engines and vehicles.

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[18] *See* 44 FR 12244 (February 23, 1979).
[19] *See* Waiver Decision on Application of E.I. DuPont de Nemours and Company (DuPont), 46 FR 6124 (February 28, 1983).

In conducting a waiver application review, EPA's emissions impact analysis concentrates on the following four major areas[20]: (1) exhaust emissions, both immediate and long-term (durability); (2) evaporative emissions, both immediate and long-term; (3) materials compatibility; and (4) driveability and operability. EPA evaluates the emissions impacts in these four categories individually and collectively and makes its final determination based on whether the new fuel or fuel additive will cause or contribute to the failure of vehicles and engines to meet their emissions standards. Each category is further discussed below.

Exhaust and evaporative emission data are analyzed according to the effects that a fuel or fuel additive is predicted to have on emissions over time. If the fuel is predicted to have only an immediate effect on emissions (i.e., the emission effects of the fuel or fuel additive are immediate and remain constant throughout the life of the vehicle or engine when operating on the waiver fuel), then "back-to-back" emissions testing will suffice. However, if the fuel or fuel additive affects the operation of the engine or related emission control hardware in a physical manner (e.g., operating temperatures, component interaction, chemical changes, increased permeation, and materials degradation) that might lead to emissions deterioration over time, test data is needed to demonstrate that the long-term durability of the emissions control system is not compromised by the fuel or fuel additive such that it would cause or contribute to the engines or vehicles failing to meet their emissions standards.

Materials compatibility issues can lead to substantial exhaust and evaporative emissions increases. In most cases, materials incompatibility issues show up in emissions testing; however, there may be impacts that do not show up due to the way the testing is performed or because the

[20] *See* 44 FR 12244 (February 23, 1979).

tests simply do not capture the effect, especially if materials compatibility effects are determined to result with use of the new fuel or fuel additive over time. EPA has required applicants to demonstrate that new fuel or fuel additives will not have materials compatibility issues.[21]

A change in the driveability of a motor vehicle that results in significant deviation from normal operation (i.e., stalling, hesitation, etc.) could result in increased emissions. These increases may not be demonstrated in the emission certification test cycles but instead are present during in-use operation In addition to consumer dissatisfaction, a motor vehicle stall and subsequent restart can result in a significant emissions increase because hydrocarbon (HC) and CO emission rates are typically highest during cold starts. Further, concerns exist if the consumer or operator tampers with the motor vehicle in an attempt to correct the driveability issue since consumers may attempt to modify a motor vehicle from its original certified configuration.

IV. Waiver Submissions and Analysis of Light-duty Motor Vehicle Issues

This section discusses Growth Energy's waiver submission, comments received on it, and EPA's waiver decision and analysis for light-duty motor vehicles. The discussion groups vehicles according to our decision: MY2007 and newer light-duty motor vehicles for which we are approving the waiver, MY2001-2006 for which we are deferring a decision, and MY2000 and older motor vehicles for which we are denying the waiver.

[21] *See* 44 FR 1447 (January 5, 1979).

As described in Section III, Method of Review, above, the Agency evaluated Growth Energy's waiver request and made its decision based on four factors: (1) exhaust emissions impact – both immediate and long-term (known as durability); (2) immediate exhaust emissions impact; (2) evaporative system impacts – both immediate and long-term; (3) the impact of materials compatibility on emissions; and, (4) the impact of drivability and operability on emissions.

A. MY2007 and Newer Light-duty Motor Vehicles

While this section discusses the rationale of our decision for MY2007 and newer light-duty motor vehicles, it references information related to other model years as Growth Energy's submission was not model year specific and neither were the comments. In addition, we believe it was important to discuss MY2007 and newer motor vehicles in the context of how they are different from earlier model year light-duty motor vehicles.

1. <u>Exhaust Emissions – Long-term Durability</u>

a. Growth Energy's Submission

For long-term durability testing ("durability testing"), Growth Energy suggests that durability testing is not required for E15 for two reasons. First, in its waiver application and public comments, Growth Energy argued that emissions testing to determine the impact of long-term use of E15 on the emissions control system is not required for E15 because EPA has waived durability testing for oxygenates in the past. Growth Energy contends that EPA has determined that oxygenates such as ethanol do not require durability testing because the Agency is "unaware of any long-term deteriorative effects on exhaust emissions associated with oxygenates"[22] and that "the vast majority of data indicate that the effect of oxygenates on exhaust emissions over time has not been a significant issue."[23] Growth Energy argued further that it would be "arbitrary and capricious" for the Agency to require durability testing for E15 considering EPA's long-standing position that oxygenates like ethanol will not have long-term exhaust emissions effects.

Growth Energy's second argument is that EPA may accept reasonable theoretical judgments regarding the emission effects of a fuel as an alternative to direct testing of motor vehicles, and that in this case, fuel volatility specification, limited durability emissions testing, and data regarding materials compatibility and driveability could be used to establish and confirm such a theory. Growth Energy suggests that the collection of studies supplied in the application, coupled with 30 years of experience using E10, provides a rational basis to develop a theory that E15 will not cause or contribute to emissions failures in motor vehicles. Growth Energy feels that the studies supplied in the application supply enough data to confirm their theory and this alleviates the need for long-term emissions testing.

In particular, Growth Energy suggests that since a study conducted by the Rochester Institute of Technology (RIT) [24] examined the effects of E20 (gasoline-ethanol blend containing

[22] *See* 53 FR 33846 (September 1, 1988).
[23] *See* 44 FR 10530 (February 21, 1979).
[24] The effect of E20 ethanol fuel on vehicle emissions, B Hilton and B Daddy, Center for Integrated Manufacturing Studies, Rochester Institute of Technology, June 26, 2009. *See* EPA-HQ-OAR-2009-0211. ("The RIT Study").

20 vol% ethanol) on 10 vehicles over significant mileage accumulation (75,000 miles combined), and found no issues when comparing E20 emissions performance with E0 (gasoline containing no ethanol) emissions performance, that "E20 will not have a significant deteriorative effect on applicable vehicle parts."[25] Growth Energy believes that this is enough information to satisfy long-term exhaust emissions testing requirements. In its comments, Growth Energy supplied an updated summary of the RIT Study which details RIT's expansion of the driveability program to 400 motor vehicles. Growth Energy argues that the updated summary of the RIT Study that they submitted in their comments has shown "no significant issues" with over 400 motor vehicles that have accumulated over 1.5 million total combined miles and found that "emissions may be reduced through use of E-20."[26] Growth Energy contends that this study confirms their theory that E15 will not cause or contribute to motor vehicles failing their emissions standards over their full useful lives.

b. Public Comment Summary

Several commenters responded that the RIT Study has limitations and does not alleviate concerns about the long-term emissions impacts of using E15 in motor vehicles. The Manufacturers of Emissions Controls Association (MECA) argues that emission control-related concerns regarding the use of E15 include the potential for accelerated thermal deactivation of three-way catalysts equipped on existing light-duty motor vehicles or nonroad engines, due to higher exhaust temperatures that have been observed on engines fueled with mid-level ethanol

[25] "Application For A Waiver Pursuant to Section 211(f)(4) of the Clean Air Act For E-15" Submitted by Growth Energy on Behalf of 52 United States Ethanol Manufacturers; EPA Docket #EPA-HQ-OAR-2009-0211-0002.6.
[26] "Growth Energy's Comments on Notice of Clean Air Act Waiver Application To Increase the Allowable Ethanol Content of Gasoline to Fifteen Percent," EPA Docket #EPA-HQ-OAR-2009-0211-2721.1.

blends in comparison to E0 and E10. MECA argues further that the thermal durability of three-way catalyst formulations is a function of time, catalyst temperature, and gas composition; extended catalyst exposure to higher exhaust temperatures, especially in the presence of oxygen-rich exhaust conditions that can be created through the use of E15, can accelerate catalyst thermal deactivation mechanisms (e.g., sintering of active precious metal sites, sintering of oxygen storage materials, and migration of active materials into inert support materials).[27]

Many commenters point out that Growth Energy submitted and cited only a summary of the RIT Study. The summary, as these commenters note, omits key details necessary to evaluate the conclusions that Growth Energy draws from the RIT Study. For example, commenters noted that the summary did not specify the make, model and year of the motor vehicles tested, making it impossible to determine the representativeness of RIT's motor vehicle test fleet. Additionally, they added that no actual data were included in the summary for commenters and the Agency to conduct independent analyses of RIT's test results. Furthermore, no detailed descriptions outlining the fuel properties of both test fuels (E0 and E20) were included in the summary. Even through Growth Energy provided an updated summary of the RIT Study in its comments, this updated summary still omitted important details necessary for commenters and the Agency to conduct an independent analysis.

Auto manufacturers, refiners, and several others similarly noted that higher exhaust temperatures could cause increased deterioration of catalysts over time. These commenters

[27] "STATEMENT OF THE MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION ON THE WAIVER REQUEST RECEIVED BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY TO INCREASE THE ETHANOL CONTENT OF GASOLINE UP TO 15%," EPA Docket #EPA-HQ-OAR-2009-0211-2441.1.

assert that this deterioration may adversely affect a motor vehicle's ability to meet emissions standards, particularly after significant mileage accumulation.

Commenters noted that a recently released Coordinating Research Council (CRC) Report E-87-1 ("the CRC Screening Study" or "E-87-1") is the first phase of another test program developed to look at the effects of mid-level gasoline-ethanol blends on U.S. motor vehicles.[28] The purpose of the study was to identify motor vehicles which used learned fuel trims to correct open-loop air-to-fuel (A/F) ratios since this may gauge the risk of the catalyst to thermal degradation.[29] This study is the first phase of a two-phase study evaluating the effects of mid-level gasoline-ethanol blends on emission control systems. The test program identified and acquired a fleet of 25 test motor vehicles with 12 of those motor vehicles manufactured after 2000. The study collected vehicle speed, oxygen sensor A/F ratio, and catalyst temperature data on four fuels (E0, E10, E15, and E20). Results compared the three gasoline-ethanol blends with E0. The study concluded that a large number of vehicles (12 of the 25 tested) failed to apply long-term fuel trim to correct for increasing ethanol levels when operating in open-loop control.

Commenters also pointed out that the CRC Screening Study showed increased exhaust temperatures in motor vehicles that failed to apply long-term learned fuel trim when operating open loop at wide open throttle using E15 and E20. This constituted seven of the sixteen vehicles tested, and the average increase was 30 degrees Celsius in these motor vehicles.

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[28] *Mid-level Ethanol Blends Catalyst Durability Study Screening* (CRC Report: E-87-1), June 2009 ("CRC Screening Study"), EPA Docket # EPA-HQ-OAR-2009-0211-13970. Available at: http://www.crcao.com/reports/recentstudies2009/E-87-1/E-87-1%20Final%20Report%2007_06_2009.pdf

[29] See section IV.A.1.c. for a detailed discussion of these terms.

Several comments refer to a series of studies conducted by Orbital Engine Company for Environment Australia to evaluate impacts E20 would have if introduced in Australia ("the Orbital Study"). The Orbital Study evaluated emissions performance on total hydrocarbon, CO, NOx and aldehydes, materials compatibility issues, and driveability of E20 compared to E0 with a test fleet of five paired late model Australian motor vehicles. The Orbital Study completed emissions testing over 80,000 kilometers (about 50,000 miles). The study notes that there were substantial increases in regulated pollutants for motor vehicles that used E20 when compared with vehicles that used E0 after the accumulation of 80,000 kilometers. The study's authors further point out that one motor vehicle operating on E20 exceeded the Australian NOx emissions standard.[30] The Orbital authors also examined catalyst efficiency changes as a possible cause of the changes in emissions as a result of aging the motor vehicles on E20. The Orbital authors conclude that the exhaust emissions increases occurred due to catalyst degradation which they attribute to the increase in exhaust temperature from E20 use during particular modes of operation. They continue by noting that the two motor vehicles that experienced dramatic emissions increases with E20 after aging were motor vehicle models that failed to adjust to the higher oxygen levels found in E20.

The Alliance of Automobile Manufacturers ("the Alliance") reasons that the Orbital Study, the CRC Screening Study, and the DOE Pilot Study[31] suggest that allowing the use of

[30] After reviewing the emissions results presented in the Orbital Study, we believe that these motor vehicles' certified emissions standards are comparable to the Tier 1 (1994 to 1999) motor vehicle exhaust emissions standards in the United States.

[31] In October 2008, DOE released a report titled *Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-road Engines, Report 1*. DOE later published an update to that report, which included all of the original study plus additional vehicles. For the purposes of this decision document, we refer to the updated study, *Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-road Engines, Report 1 – Updated*, National Renewable Energy Laboratory, February 2009, as the "DOE Pilot Study". EPA Docket #EPA-HQ-OAR-2005-0161-2880.

E15 in motor vehicles could cause a substantial number of motor vehicles to fail emissions standards because of increased catalyst deterioration over the motor vehicles' full useful life, especially in so-called "legacy vehicles" which constitute a bulk of the American motor vehicle fleet. The Alliance asserts that this uncertainty of the long-term effects of E15 on catalysts durability would require motor vehicle testing over the full useful life to address these concerns. The Alliance for a Safe Alternative Fuels Environment ("AllSAFE") concluded that legally "when the relevant effects can include accelerated catalyst deterioration, 'back to back' testing to determine so-called 'immediate' emissions impacts is not sufficient."[32]

Growth Energy submitted two responses to the Orbital Study. First, Growth Energy commented that the motor vehicles tested in the Orbital Study were designed for Australian emission standards and are not representative of motor vehicles found in the US. Second, since much of the research Orbital relied on was conducted in the 1980s and early 1990s, Growth Energy points out that the "US fleet has been redesigned significantly since the mid-1980s to accommodate different fuel blends and meet the world's most stringent emission regulations."[33]

Specifically addressing the issue of higher catalyst temperatures, Growth Energy, ACE, and others responded in their respective comments that higher catalyst temperatures are not necessarily harmful to the catalysts.[34] They point out that the catalyst temperature increases in the DOE Pilot Study were relatively small and well within normal operating temperatures.

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[32] "Exhibit B, Supplemental Statutory Appendix To the Comments of the Alliance for a Safe Alternative Fuels Environment On the Request for Waiver of the Prohibition in Section 211(f)(1) of the Clean Air Act Noticed for Comment at 74 Fed. Reg. 18,228 (April 21, 2009)", submitted by AllSAFE, EPA Docket #EPA-HQ-OAR-2009-0211-2559.2.

[33] "ATTACHMENT A: Responses to Anecdotes and Unfounded Claims Regarding E-15," submitted by Growth Energy, EPA Docket #EPA-HQ-OAR-2009-0211-2721.2.

[34] In fact, ACE argues that these increased catalyst temperatures may be responsible for the average decreases in NOx emissions found in the DOE Study and RIT Study. *See* ACE's Comment, 8.

These commenters also note that the temperatures only occurred in certain motor vehicles and only when those motor vehicles were operated in the rarely used wide open throttle mode. Growth Energy points out that for the seven motor vehicles that adjusted for the extra oxygen from the increased ethanol blends, catalyst temperatures were cooler on average.

c. EPA Response Regarding the Need for Long-term Exhaust Emissions (Durability) Testing

i. *General Long-Term Exhaust Emissions (Durability) Concerns*

Ethanol impacts motor vehicles in two primary ways. First, as discussed below, ethanol enleans the A/F ratio (increases the proportion of oxygen relative to hydrocarbons) which can lead to increased exhaust gas temperatures and potentially increase incremental deterioration of emission control hardware and performance over time, possibly causing catalyst failure. Second, ethanol can cause materials compatibility issues, which may lead to other component failures (this will be discussed further in sections IV.A.3 and IV.A.4 below). Ultimately, either of these impacts may lead to emission increases.

Due to the increased oxygen content of E15 relative to E10, motor vehicles operated on E15 will likely run even leaner than those operated on E10 depending on the vehicle technology and operating conditions. It is also relevant to note that all motor vehicles are emissions and durability tested for exhaust emissions certification purposes using an E0 fuel; therefore, this effect of changing from E10 to E15 will not be present during certification and compliance testing. Enleaned combustion leads to an increase in the temperature of the exhaust gases. This increase in exhaust gas temperatures has the potential to raise the temperatures of various exhaust system components (e.g., exhaust valves, exhaust manifolds, catalysts, and oxygen sensors) beyond their design limits. However, based on past experience, the most sensitive component is likely the catalyst, particularly in older motor vehicles with early catalyst technology. Catalyst durability is highly dependent on temperature, time, and feed gas composition. Catalyst temperatures must be controlled and catalyst deterioration minimized during all motor vehicle operation modes for the catalyst to maintain high conversion efficiency over the motor vehicle's full useful life (FUL). This is particularly important during high-load operation of a motor vehicle where the highest exhaust gas temperatures are typically encountered and the risk for catalyst deterioration is the greatest. Catalysts that exceed temperature thresholds will deteriorate at rates higher than expected, compromising the motor vehicles' ability to meet the required emission standards over their FUL. Extended catalyst exposure to higher exhaust temperatures can accelerate catalyst thermal deactivation mechanisms (e.g., sintering of active precious metal sites, sintering of oxygen storage materials, and migration of active materials into inert support materials). While this damage can occur at a highly accelerated rate with a sudden change in temperature (e.g., with a misfire allowing raw fuel to reach the catalyst), it is more likely to occur over time from elevated exhaust temperatures as may be experienced with frequent or even occasional exposure to E15. This deterioration may adversely affect a motor vehicle's ability to meet emissions standards, particularly after significant mileage accumulation.

Some motor vehicles may be designed in ways that manage catalyst temperatures by compensating for the oxygen in the fuel under all operating conditions, including high loads. This is achieved by using a closed-loop fuel system that measures the A/F ratio and makes the appropriate corrections to maintain the A/F ratio in the very tight band of operation around stoichiometry necessary for optimum catalyst performance and reductions in HC, CO, and NOx emissions. The corrections can be applied to other areas of operation to achieve the desired A/F ratio. The part of the closed-loop fuel system that is responsible for the correction to the A/F ratio is referred to as “fuel trim.” The fuel trim adds or removes fuel to the engine in order to maintain the required A/F ratio. If the measured A/F ratio has insufficient oxygen or is “rich,” compared to what the engine needs, the fuel trim will instruct the fuel injectors to inject less fuel, making the A/F ratio “leaner.” The opposite is true if the measured A/F ratio has too much oxygen and needs to inject more fuel for a “richer” A/F ratio. The fuel trim is generally comprised of two major parts, short-term fuel trim and long-term or learned or adaptive fuel trim. Learned or adaptive fuel trim can also be applied to open-loop operation such as high-load or wide-open throttle to alleviate the catalyst temperature increases caused by operating on E15. However this practice has not been consistently employed by all manufacturers.

ii. Response to Growth Energy’s First Argument

In its first argument Growth Energy asserted that long-term exhaust emissions testing (“durability testing”) is not required for E15 because EPA has waived durability testing for oxygenates in previous waiver decisions. The Agency believes that Growth Energy’s waiver request application is different in substantial ways from previous oxygenate waiver applications that EPA has reviewed. Previous oxygenate waivers have, at most, resulted in increased fuel oxygen levels of up to around 2.7% by weight oxygen. E15, for the first time, would add significantly more oxygen to the fuel, up to around 5.5% by weight oxygen depending on the density of the gasoline to which ethanol is added. This increase in oxygen content is double the current oxygen content limit that EPA interprets to be substantially similar to motor vehicle gasoline used in the certification of motor vehicles.[35] Additionally, with the exception of the original E10 waiver, which was not granted through an EPA decision but through the operation of law,[36] and the Tertiary-butyl Alcohol waiver, which leads to oxygen content of about 1.6 percent, EPA has placed a condition on all other gasoline-alcohol waivers requiring a corrosion inhibitor to deal with the aggressive nature of these fuels.

In addition to this very large increase in oxygen content compared to the waivers granted by EPA over 20 years ago, the emissions standards that motor vehicles must achieve have become much more stringent over time. As a result, emissions control systems have also changed significantly over time. The emissions controls systems of vehicles over the last 20 years have progressively become more dependent on the ability to control the deterioration of the emissions control system, especially the catalyst, to achieve compliance with the emissions standards over the full useful life of the motor vehicle. Of particular importance is the ability of emissions control systems over time to limit or control long-term deterioration by accounting for the oxygen level of the fuel. The oxygen content levels at issue in this waiver application raise serious concerns about long-term durability. This concern is supported by information in several studies.

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[35] *See* 73 FR 22277 (April 25, 2008).
[36] *See* 44 FR 20777 (April 6, 1979).

For both of these reasons, EPA rejects Growth Energy's claim that long-term exhaust emissions (durability) testing is not required for the E15 waiver request and that it would be arbitrary or capricious for EPA to require durability testing for this waiver.

iii. Response to Growth Energy's Second Argument

Growth Energy in its second argument concluded that E15 does not require long-term exhaust emissions (durability) test data, because, as they state, EPA may accept reasonable theoretical judgments as to the emission effects of a fuel as an alternative to the direct testing of motor vehicles. However, Growth Energy has not presented a reasonable and valid engineering theory to demonstrate that E15 will not detrimentally impact the durability of emissions control systems such that engines and vehicles can still meet their emissions standards while using E15 They point to fuel volatility specification, limited durability emissions testing, data regarding materials compatibility and driveability, as well as the collection of studies supplied in the application, coupled with 30 years of experience with using E10, as providing a rational basis for a theory that E15 would not cause long-term deterioration of the emissions control systems of motor vehicles. However, this is not an engineering theory or an engineering analysis. Growth Energy has not analyzed the design of emissions control systems and their changes over time, as emissions standards have increasingly become more stringent. Nor has Growth Energy explained from an engineering perspective why in theory the oxygen levels found in E15 should not lead to durability problems for the emissions control system when used over time. Instead, Growth Energy points to the same information as both the source of its theory as well as the data used to confirm its theory. This highlights the circular nature of Growth Energy's argument, as well as the absence of an engineering analysis that identifies and explains any theory Growth Energy relies upon.

Absent such a theory, one would perform the durability testing and draw conclusions from such testing about the impact of E15 on long-term durability. In essence, Growth Energy is suggesting that the data and testing it presents provides such an evidentiary basis and is as credible as data gathered from actual long-term durability testing for drawing such conclusions. Instead of presenting a reasoned engineering theory and data to confirm it, they are presenting what amounts to an alternative evidentiary basis to long-term durability testing. However, the information that Growth Energy relies on is not adequate to provide such as basis.

For example, the RIT Study that Growth Energy cites does not support the conclusions that Growth Energy draws from this test program. Specifically, Growth Energy argues that because the RIT Study had run 10 motor vehicles over 75,000 miles without any serious issues, a reasonable theory concerning E15's effects on long-term durability may be inferred. However, 10 motor vehicles run over 75,000 miles on E20 is only an average of 7,500 miles per motor vehicle. This is substantially lower than the 100,000/120,000 full useful life of the motor vehicles in the test program. Similarly, Growth Energy argues that the expanded RIT Study ran 400 motor vehicles over 1.5 million combined miles without significant issues. However, 400 motor vehicles run over 1.5 million miles is an average of 3,750 miles per motor vehicle. Additionally, Growth Energy suggests that RIT found decreases in the emissions of regulated pollutants in RIT's 400-vehicle driveability study, but no actual emissions testing on those motor vehicles was performed. In the updated RIT summary that Growth Energy submitted during the comment period, RIT had not conducted any additional motor vehicle emissions testing since the earlier summary.

Although the initial emissions testing conducted in 2008 may suggest decreases in regulated pollutants, it does not address concerns that increased ethanol levels in gasoline may lead to increased exhaust temperatures, increased catalyst deterioration, and increased emissions over time. Since the RIT study only performed emissions testing on 10 of the vehicles (4 of which were Ford F250 trucks), and the mileage accumulated on E20 for each vehicle was far less than the 120,000 mile FUL, it is not possible to draw adequate conclusions concerning long-term emissions from the RIT Study even after the completion of the test program.

The Agency finds that none of the other studies or information cited by Growth Energy specifically addresses the concern with the effect of increased exhaust temperatures due to increased ethanol levels and how that will impact the motor vehicles' ability to meet their emissions standards over their useful life. The studies and material may provide information relative to other aspects of ethanol impacts but fall short of providing any substantive information on the long-term effects of midlevel gasoline-ethanol blends on emissions control systems. Nor do any of the studies that Growth Energy cites provide sufficient information to lead the Agency to believe that there will not be long-term durability concerns. Growth Energy did not provide any data or analysis of warranty or repair information from in-use experience with E10 vs. E0 with which to assess what the impact has been over the last 30 years from the use of E10 in the in-use fleet, nor any information showing how the results of such an analysis would change with the use of E15. Therefore, we do not agree with Growth Energy that durability testing is not required.

The Agency concludes that the studies and other information cited in Growth Energy's waiver request application, and its public comments, do not demonstrate that E15 is not likely to have adverse impacts on the long-term exhaust emissions (durability) of the emissions control system over the full useful life of motor vehicles. The DOE Pilot Study, the CRC Screening Study, the Orbital Study, comments from the automobile manufacturers, and our engineering judgment, as discussed below, all indicate that legitimate concerns exist that E15 could accelerate the deterioration of the catalysts in a sizeable portion of the national fleet, leading to increased emissions.

Therefore, EPA finds that the limited durability testing and other information relied upon by Growth Energy is not adequate by itself to determine the long-term durability impact of E15 on exhaust emissions control systems.

d. Durability Studies and EPA Analysis

A number of regulatory actions have taken place since 2000 which have placed an emphasis on real-world testing of motor vehicles, which in turn has led to changes in emission control systems. First, the Compliance Assurance Program, more commonly known as CAP2000, took effect with MY2001 motor vehicles and was designed to place more emphasis on the "in-use" performance (or the performance of motor vehicles once they are in customer service) of motor vehicle emission controls with motor vehicles operating nationwide on the different available fuels. The In-Use Verification Program (IUVP) introduced under CAP2000 requires manufacturers to perform exhaust and evaporative emissions tests on customer motor vehicles at low and high mileage intervals. This emphasis on real-world motor vehicle testing provided manufacturers with increased incentive to consider the impacts of different marketplace fuels, including E10, when developing and testing their emissions control systems.

Second, by MY2004, Supplemental Federal Test Procedure (SFTP) emissions standards were fully phased in. SFTP emissions standards expanded vehicle emission testing to better represent actual consumer driving habits and conditions by including the US06 test (a high speed and high acceleration cycle), the SCO3 test (an air conditioning test cycle run in a environmental test chamber at 95 °F), and a 20°F cold test run on the Federal Test Procedure (FTP) cycle. In response to these requirements manufacturers developed more robust emissions control systems (such as systems using wide range oxygen sensors) capable of withstanding the higher temperatures experienced during these more severe cycles without simply relying on enriching of the A/F ratio, causing emissions to rise.

Third, beginning with MY2004, the Agency implemented its current and most stringent emission standards – the Tier 2 standards, with full implementation for light-duty motor vehicles and trucks and medium duty passenger motor vehicles completed by MY2007. Importantly, in order to comply with Tier 2 full useful life requirements, additional changes were required to ensure the durability of the exhaust and evaporative emission control systems over “real world” conditions.

As a result of all of these standards, Tier 2 motor vehicles (i.e. motor vehicles subject to the Tier 2 standards) are more technologically advanced and robust than cars built years ago. These motor vehicles have improved hardware as well as more sophisticated emissions control systems and strategies to help maintain catalyst effectiveness throughout the extended motor vehicle operating range over which emissions performance must be maintained. Motor vehicles now have the ability to precisely adjust for changes in the A/F ratio of the engine and ultimately maintain peak catalyst efficiency under almost any condition, such as exposure to oxygenated fuels like those containing ethanol. Auto manufacturers now warrant their new motor vehicles to operate on gasoline-ethanol blends up to E10.

While the Tier 2 regulations allowed new motor vehicles to phase-in to the Tier 2 standards from MY2004-2009, actual manufacturer certification data indicates that gasoline-fueled motor vehicles reached full phase-in with MY2007. MY2004-2006 motor vehicles include a mix of Tier 2 and "interim non-Tier 2" motor vehicles. Only some flexible-fueled vehicles (FFVs) and diesel motor vehicles remained as interim non-Tier 2 motor vehicles in MY2008 and 2009.

To comply with the stringent Tier 2 standards, manufacturers must minimize deterioration of the emissions control system over a motor vehicle's FUL of 120,000 miles (40 CFR 86.1811-04). In particular, catalyst deterioration must be minimized and catalyst temperatures controlled during all motor vehicle operation modes for the catalyst to work properly (i.e., for it to maintain the necessary high efficiency demanded by the Tier 2 standards). To do so, some manufacturers incorporated learned or adaptive fuel trim into their motor vehicle designs to help control the A/F ratio and alleviate catalyst temperature increases even under open-loop conditions. Others, through careful hardware selection and certain calibration approaches, designed their motor vehicles with higher thermal margins to accommodate the effects of enleanment with gasoline-ethanol blends. Regardless of their approach, all manufacturers have warranted their Tier 2 vehicles for operation on E10, and we believe, based on available data, that they are capable of operating on gasoline-ethanol blends up to E15 as well.

The test data that has been collected supports our engineering assessment. Several test programs were conducted by CRC, the National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory and DOE to study the effects of E15 on Tier 2 vehicles, with the key study being the recently completed DOE Catalyst Study, discussed in more detail below. The CRC Screening Study and the DOE Pilot Study measured exhaust and catalyst temperature and/or evaluated the ability of motor vehicles to apply learned fuel trim to adjust for the enleanment due to ethanol during open-loop operation. As discussed above, leaner, hotter exhaust subjects the catalyst to greater risk of high temperatures and long-term catalyst deterioration and damage, and applying the learned fuel trim to open-loop operation is one of several methods manufacturers use to protect against this. Since roughly half of the motor vehicles tested in these test programs, including roughly half of the Tier 2 motor vehicles, did not apply learned fuel trim, and those motor vehicles that did not apply learned fuel trim experienced higher catalyst and exhaust temperatures with E15, these screening studies highlighted the potential for concern. However, the lack of compensating for ethanol content while in open-loop operation indicates only the potential for temperature problems to occur, and elevated temperatures only indicate the potential for catalyst deterioration; motor vehicles that do not apply learned fuel trim may still have sufficient thermal margins.

To evaluate the actual impacts of E15 on Tier 2 motor vehicles, DOE performed a catalyst durability test program[37], the DOE Catalyst Study, throughout 2009 and 2010 on 19 Tier 2 motor vehicle models from high sales volume models of the various light-duty motor vehicle manufacturers. The specific purpose of the program was to evaluate the long term effects of E0, E10, E15, and E20 on catalyst system durability. The program also provided other limited but valuable information relevant to today's partial waiver decision, such as materials compatibility, evaporative control system integrity, diagnostic system sensitivity and general driveability. Without the results from this test program, EPA would not have had the information necessary to properly assess the long-term exhaust emission (durability) performance of E15. Program results indicate that the changes manufacturers made (calibration, hardware, etc.) to their motor vehicles to comply with the Tier 2 standards have in fact resulted in the capability of the motor vehicle catalysts to withstand the additional enleanment caused by E15, regardless of whether or not the motor vehicles utilized learned fuel trim while in open-loop operation. The test program results show that a representative cross section of the Tier 2 fleet maintained their exhaust emission performance on E15 over the full useful life of the motor vehicles. The discussion which follows contains a description of the DOE Catalyst Study and presents and analyzes its results.

i. *DOE Catalyst Study Overview*

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[37] *Catalyst Durability Study*, Department of Energy Tier 2 vehicle testing completed September 2010. Final report due early 2011.

The Intermediate Ethanol Blends Emissions Controls Durability Test Program ("DOE Catalyst Study") was established in 2008, following enactment of the Energy Independence and Security Act of 2007, to investigate the potential impacts of gasoline-ethanol blend levels above 10% on the durability of vehicle emissions control systems. The program was subcontracted to Southwest Research Institute (SwRI), Transportation Research Center (TRC) and Environmental Testing Corporation (ETC).

ii. *Vehicle Selection and Matching*

Several relevant criteria were used to determine the motor vehicle models selected:

- Tier-2 compliant
- Manufacturer and sales/registration volumes
- Whether a motor vehicle did or did not apply learned fuel trim (LFT or non-LFT, respectively) at wide-open throttle (WOT).

Other studies also impacted selection: EPA's EPAct motor vehicle study at Southwest Research Institute (SwRI) which was expanded into the CRC's E-89 study[38], CRC's E-87-1 study (CRC Screening Study), and the DOE Pilot Study. Based on the motor vehicle models EPA used to represent the Tier 2 fleet in the CRC E-89 study, DOE consulted with CRC and then instructed the national laboratories to utilize the same set of motor vehicle models for the

[38] E-89, Energy Policy Act (EPAct) Light-duty Vehicle Fuel Effects. (EPA and the National Renewable Energy Laboratory (NREL) are sponsoring extensive testing of ethanol fuel effects in connection with project E-89.)

long-term durability studies, with one exception (at the request of CRC, they switched out a Toyota Sienna for a Nissan Quest).

All the motor vehicles within a model set (one motor vehicle for each fuel tested within a model) were matched to prevent confounding of the data by undesirable motor vehicle attribute changes. The engine family, engine displacement, evaporative emissions control family, model year, powertrain control unit calibration, axle ratios, wheel size, and tire size were constrained to be identical within a motor vehicle set. Physical inspections of the motor vehicles to eliminate obvious problematic motor vehicles (such as those with gross fluid leaks, obvious and excessive body damage, etc.) were also a part of the selection. Pre-owned motor vehicles' initial odometer readings were to be within 10,000 miles amongst a motor vehicle set.

Table IV.A -1 Vehicle Attribute Summary.

V4 Project Vehicle Summary (Vehicle Aging)				Engine								
				Displ	config	Engine Family	Emissions Standard and Limits				Starting Odometer (x1000miles)	
Southwest Research Institute (Texas)								NMOG	CO	NOx	E0	E15
Year	Vehicle	Fuels										
2006	Chevrolet Silverado	E0	E15	5.3	V8	6GMXT05.3379	Tier 2/ Bin 8	0.156	4.2	0.2	28	17
2007	Honda Accord	E0	E15	2.4	I4	7HNXV02.4KKC	Tier 2/ Bin 5	0.09	4.2	0.07	32	31
2008	Nissan Altima	E0	E15	2.5	I4	8NSXV02.5G5A	Tier 2/ Bin 5	0.09	4.2	0.07	19	10
2008	Ford Taurus	E0	E15	3.5	V6	8FMXV03.5VEP	Tier 2/ Bin 5	0.09	4.2	0.07	17	17
2007	Chrysler Caravan	E0	E15	3.3	V6	7CRXT03.8NE0	Tier 2/ Bin 5	0.09	4.2	0.07	46	40
2006	Chevrolet Cobalt	E0	E15	2.2	I4	6GMXV02.4029	Tier 2/ Bin 5	0.09	4.2	0.07	39	48
2007	Dodge Caliber	E0	E15	2	I4	7CRXB02.4MES	Tier 2/ Bin 5	0.09	4.2	0.07	41	48
Transportation Research Center (Ohio)												
Year	Vehicle	Fuels										
2009	Jeep Liberty	E0	E15	3.7	V6	9CRXT03.74PO	Tier 2/Bin 5	0.09	4.2	0.07	4	4
2009	Ford Explorer	E0	E15	4	V6	9FMXT04.03DC	Tier 2/Bin 4	0.07	4.2	0.04	4	4
2009	Honda Civic	E0	E15	1.8	I4	9HNXV01.8XB9	Tier 2/Bin 5	0.09	4.2	0.07	4	4
2009	Toyota Corolla	E0	E15	1.8	I4	9TYXV01.8BEA	Tier 2/Bin 5	0.09	4.2	0.07	4	4
2005	Toyota Tundra	E0	E15	4	V6	5TYXT04.0NEM	Tier 2/ Bin 5	0.09	4.2	0.07	54	44
2006	Chevrolet Impala	E0	E15	3.9	V6	6GMXV03.9048	Tier 2/Bin 5	0.09	4.2	0.07	31	36
2005	Ford F150	E0	E15	5.4	V8	5FMXT05.4R17	Tier 2/Bin 8	0.156	4.2	0.2	42	45
2006	Nissan Quest	E0	E15	3.5	V6	6NSXT03.5G7B	Tier 2/Bin 5	0.09	4.2	0.07	57	55
Environmental Testing Corp (Colorado)												
Year	Vehicle	Fuels										
2009	Saturn Outlook	E0	E15	3.6	V6	9GMXT03.6151	Tier 2/Bin 5	0.09	4.2	0.07	4	4
2009	Toyota Camry	E0	E15	2.4	I4	9TYXV02.4BEA	Tier 2/Bin 5	0.09	4.2	0.07	4	4
2009	Ford Focus	E0	E15	2.0	I4	9FMXV02.0VDX	Tier 2/Bin 4	0.07	4.2	0.04	4	4
2009	Honda Odyssey	E0	E15	3.5	V6	9HNXT03.5J29	Tier 2/Bin 5	0.09	4.2	0.07	4	4

iii. *Fuels and Blending*

Emissions and related tests were conducted using an emissions certification gasoline and splash blending batches of E10, E15, and E20 on site. The gasoline-ethanol blends were blended from emissions certification gasoline and denatured fuel-grade ethanol. These emissions test fuels were termed E0 (for ethanol-free emissions fuel), E10 (for 10% ethanol emissions fuel), E15 (for 15% ethanol emissions fuel) and E20 (for 20% ethanol emissions fuel).

Aging fuels were produced by splash blending fuel-grade ethanol with non-ethanol containing gasoline obtained commercially by the subcontractors in their local area, rather than emissions certification gasoline. The aging fuels were designated RE0, RE10, RE15, and RE20 with "R" conveying blending from retail gasoline.

iv. *Emissions Test Protocol*

Motor vehicles were subjected to emissions (FTP) and related tests at the following points during the test program: (1) at the beginning of mileage accumulation; (2) at least one mid-mileage point; and (3) at the end of mileage accumulation. DOE consulted with CRC on recommended testing procedures. At SwRI and TRC, the acceptance tests also included WOT tests to aid in classifying the vehicles as either LFT or non-LFT motor vehicles. At each emissions test interval, duplicate FTP tests were conducted on each motor vehicle using both the gasoline-ethanol blend assigned to the motor vehicle as well as E0. (i.e. the "E15" motor vehicle received duplicate FTPs on both E15 and E0.) The motor vehicles also underwent compression and leak-down checks at each emissions interval. Tier 2 compliant motor vehicles were driven up to their full-useful life (120,000 miles). The initial mileages of the Tier 2 motor vehicles ranged from near zero to approximately 50,000 miles. These vehicles were driven approximately 70,000-120,000 miles during the program.

New motor vehicles were first aged to 4,000 miles to stabilize the engine and emissions control systems, followed by the initial emissions test. The motor vehicles then accumulated mileage until the first mid-aging emissions tests at 60,000 miles. This cycle was then repeated to 90,000 miles for the motor vehicles under test at ETC. At TRC and SwRI, the 90,000 mile emissions tests were not conducted. All vehicles ended aging at 120,000 miles. Pre-owned motor vehicle sets with less than 70,000 miles at the start were mid-aging tested at 95,000 miles with end-of-aging tests at 120,000 miles.

v. *Mileage Accumulation*

The standard road cycle (SRC) was used for all aging. The SRC is the official EPA driving cycle used for aging in the whole motor vehicle exhaust durability procedure. This is a recommended EPA procedure that the manufacturers regularly use for verifying full useful life emissions capability. It has an average speed of 46.3 mph and a maximum of 75 mph. The Nissan Quest aging was changed part way through aging to a series of steady speed laps on the test track at TRC at DOE’s direction to accelerate completion of this motor vehicle set.

ETC and SwRI used mileage accumulation dynamometers (MADs) for aging. Motor vehicles at TRC were aged on a closed test track. Drivers followed the SRC as they drove the motor vehicles around the track. To complete the test program required motor vehicles to undergo anywhere from six to nine months of mileage accumulation and emission testing.

vi. *Powertrain Component Inspection*

At the end of motor vehicle mileage accumulations and emissions testing at SwRI, six pairs of engines were disassembled and analyzed for signs of wear and materials compatibility problems of concern with gasoline-ethanol blends that might indicate durability concerns with

E15 that did not show up in the accelerated aging testing performed.[39] The eight different types of evaluations performed included:

- Evaporative Emission System Integrity Check – a low pressure smoke leak test
- Evaporative Canister Butane Working Capacity Check
- Cam Lobe Wear – measuring overall cam height to indicate wear
- Valve Seat Width and Valve Surface Contour – to measure wear on the valve seat
- Valve Stem Height – to assess valve seat recession
- Intake Valve Deposit measurement
- ASTM D5185 Analysis of Engine Oil Drain Samples – to assess the presence of unusually high levels of wear metals
- Fuel Pump Flow Evaluation

vii. *Summary and Conclusions of the Final Results of the DOE Catalyst Study*

Tier 2 motor vehicle testing concluded in late September. Analysis of the FUL emissions performance and emissions deterioration rates showed no significant difference between the E0 and E15 fueled groups. As shown in Tables 2 and 3 below, three E0 aged motor vehicles had failing emissions levels at the end of the test program and one additional motor vehicle failed one of several replicate tests. Two E15 aged motor vehicles had failing emissions levels at the end of the test program. However, none of the emissions failures appeared to be associated with the

[39] Southwest Research Institute (SwRI) Project 08-58845 Status Report, "Powertrain Component Inspection from Mid-Level Blends Vehicle Aging Study," September 6, 2010. EPA Docket #EPA-HQ-OAR-2009-0211-14016.

differences in the aging fuels. There were no emissions component or material failures during aging that were related to fueling. There was a catalyst efficiency fault code on an E0 motor vehicle but not on the E15 counterpart.

Table IV.A-2 E0 FUL Results Compared to Tier 2 Standards[40]

Year	Model	LFT@WOT	Nox	NMOG	CO
2007	Accord	N	Pass	Pass	Pass
2006	Silverado	Y	Pass	Pass	Pass
2008	Altima	N	Pass	Fail	Pass
2008	Taurus	Y	Pass	Pass	Pass
2007	Caravan	N	Pass	Pass	Pass
2006	Cobalt	N	Pass	Pass	Pass
2007	Caliber	N	Fail	Pass	Pass
2009	Civic	N	Pass	Pass	Pass
2009	Explorer	Y	Pass	Pass	Pass
2009	Corolla	Y	Pass	Pass	Pass
2009	Liberty	N	Pass	Pass	Pass
2005	Tundra	Y	Pass	Pass	Pass
2006	Impala	Y	Pass	Pass	Pass
2005	F150	Y	Pass	Pass	Pass
2006	Quest	N	N/A	N/A	N/A
2009	Outlook	Y	Pass	Pass	Pass
2009	Camry	Y	Pass	Pass	Pass
2009	Focus	Y	Fail	Pass	Pass
2009	Odyssey	N	Pass*	Pass	Pass
	Total Fails		2	1	0

*Denotes that average of emissions tests were below applicable FUL standard, but had at least one test value above the applicable FUL standard.

[40] Our assessment of motor vehicles that exceeded emissions standards at FUL mileage accumulation is that the exceedances were not attributable to the fuel used.

Table IV.A- 3 E15 FUL Results Compared to Tier 2 Standards[41]

Year	Model	LFT@WOT	Nox	NMOG	CO
2007	Accord	N	Pass	Pass	Pass
2006	Silverado	Y	Pass	Pass	Pass
2008	Altima	N	Pass	Pass	Pass
2008	Taurus	Y	Pass	Pass	Pass
2007	Caravan	N	Pass	Pass	Pass
2006	Cobalt	N	Pass	Pass	Pass
2007	Caliber	N	Pass	Pass	Pass
2009	Civic	N	Pass	Pass	Pass
2009	Explorer	Y	Pass	Pass	Pass
2009	Corolla	Y	Pass	Pass	Pass
2009	Liberty	N	Pass	Pass	Pass
2005	Tundra	Y	Pass	Pass	Pass
2006	Impala	Y	Pass	Pass	Pass
2005	F150	Y	Pass	Pass	Pass
2006	Quest	N	Fail	Pass	Pass
2009	Outlook	Y	Pass	Pass	Pass
2009	Camry	Y	Pass	Pass	Pass
2009	Focus	Y	Fail	Pass	Pass
2009	Odyssey	N	Pass	Pass	Pass
	Total Fails		2	0	0

*Denotes that average of emissions tests were below applicable FUL standard, but had at least one test value above the applicable FUL standard.

Using standard statistical tools, the resulting test results shown in Tables IV.A-2 and IV.A-3 support the conclusion that E15 does not cause Tier 2 motor vehicles to exceed their exhaust emission standards over their useful life.

[41] Our assessment of motor vehicles that exceeded emissions standards at FUL mileage accumulation is that the exceedances were not attributable to the fuel used.

We performed a statistical analysis of this emission data to assess the impact of E15 on the rate of deterioration of exhaust emissions. We used a general linear model in SPSS™ to perform this analysis. Each individual test motor vehicle was allowed its own base level of emissions (e.g., the Taurus aged on E0 was allowed one base emission level and the Taurus aged on E15 was allowed a different base emission level). This reflects the fact that individual motor vehicles, even of the same design, have emissions levels that differ to at least the same order of magnitude as the effect of fuel quality on emissions. Each model type (e.g., all of the Taurus motor vehicles as a group) was also allowed its own rate of emissions deterioration. This reflects the fact that motor vehicle design has a significant impact on the rate of emissions deterioration. We then tested the hypothesis that the effect of aging the motor vehicle on E15 caused a non-zero change in the rate of change in non-methane organic gases (NMOG) and NOx emissions. Each emission test was weighted to reflect the number of replicates performed on that motor vehicle at a specific mileage test point. For example, if only two replicate tests were performed on the Taurus aged on E0 at it mid-level test point (i.e., 67,000 miles), then each emission test was assigned a weight of 0.5. If three replicate tests were performed at that mileage, then each emission test was assigned a weight of 0.33.

The statistical analysis of the remaining Tier 2 exhaust emission data indicated that the rate of deterioration in NMOG emissions decreased on average, while that for NOx emissions increased. However, the impacts were not statistically significant deterioration at the 90% confidence level.[42] Thus, due to the variability in the effect across the various test motor

[42] The Agency has typically used a confidence level of 90% in CAA section 211(f)(4) waiver requests instead of the more conventional 95% confidence level. We feel that the 90% confidence level increases the likelihood that

vehicles, we cannot confidently reject the hypothesis that the emission deterioration rates on both blends are the same. In other words, there is a significant chance that the average impacts observed are the result of the randomness in the data. This conclusion is supported by the fact that the average changes in NMOG and NOx emissions deterioration rates went in opposite directions. If the catalysts had in fact been deteriorating faster with E15, then all emissions should have deteriorated consistently. Therefore, the catalyst durability test program results also support the conclusion that E15 will not contribute to Tier 2 motor vehicles exceeding their emission standards over their full useful life. The details of this statistical analysis can be found in an EPA Technical Summary located in the docket to this waiver decision.[43]

The results of the vehicle tear-down inspections were analyzed to assess whether E15 exhibited any signs of wear or materials incompatibility that might indicate durability concerns that could lead to elevated exhaust or evaporative emissions that might not have shown up in the FUL emission testing performed.[44] For seven of the eight evaluations performed, there were no apparent differences at the end-of-life between the motor vehicles that were operated on E15 and E0. While individual motor vehicle results varied (as one would expect in inspections such as this), there was no pattern that would suggest greater deterioration on E15, and none of the measurements indicated are a cause for a concern over powertrain durability for the Tier 2 motor vehicles evaluated. The one area where motor vehicles aged on E15 differed in their results was intake valve deposits. E15 showed a consistent and often significant increase in intake valve deposits in comparison to E0. This is not surprising given that prior detergent additive studies

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increases in deterioration would be statistically significant and therefore would be more conservative in this case. However, these differences are also not statistically significant at the 95% confidence level.

[43] Technical Summary of DOE Study on E15 Impacts On Tier 2 Vehicles and Southwest Research Teardown Report. EPA Docket #EPA-HQ-OAR-2009-0211.

[44] Ibid.

have shown E10 to be a more severe test fuel for intake valve deposits than E0. For this very reason the fuel on which fuel additive manufacturers must certify their detergent additive packages contains 10 vol% ethanol. Since the Tier 2 motor vehicles did not show increased exhaust emission deterioration over their FUL with E15 in comparison to E0, the increased intake valve deposits do not appear to have lead to a corresponding emissions increase. As a result, the finding that E15 leads to increased intake valve deposits appears to be primarily an issue to be addressed in future gasoline detergent additive formulations.

Finally, the CRC engine durability study[45] has limited relevance for the waiver decision because it used only E20 fuel. Initial data is for eight motor vehicles ranging from MY2001-2009 with initial mileage as high as 110,000miles. The engines were removed and dynamometer-aged for 500 hours with 50% of the time at wide-open throttle (3500rpm). Since the study used only E20 fuel and did not test matching engines aged on E0, there is no way to determine the influence of the fuel blend on engine deterioration. There were some elevated leakdown measurements observed in the study but there is no way to determine if they were fuel blend related or would have occurred even with E0 fuel. Also, several motor vehicles were listed as failing the leak tests yet the motor vehicles passed the leak test at later points in the study. In any event, all the engines that completed aging passed their motor vehicle emissions tests.

2. Exhaust Emissions - Immediate Effects for MY2007 and Newer Light-duty Motor Vehicles

[45] CRC Project No. CM-136-09-1B Engine Durability Study of Mid-Level Ethanol blends, EPA Docket #EPA-HQ-OAR-2009-0211-14003.5.

Instantaneous or immediate impacts of a fuel or fuel additive are those that are experienced essentially immediately upon switching from the original fuel. In the case of this partial waiver decision, the immediate exhaust emission impacts of interest are those that are caused by E15 in comparison to E0, which is the fuel on which the motor vehicles were certified. The immediate exhaust emission impacts must be taken into consideration along with the long-term or durability emission impacts discussed in the previous section in assessing the waiver. This section discusses the immediate exhaust emission impacts on MY2007 and newer light-duty motor vehicles. Discussion of immediate exhaust emission impacts on other motor vehicles is addressed in their respective sections. However, since Growth Energy's submission and information supplied by commenters regarding immediate emission impacts of E15 were not specific to the model year of the motor vehicles, this section also contains much of the information on immediate emission impacts for other vehicles as well.

a. Growth Energy's Submission

Growth Energy supplied data produced from several test programs that measured the immediate emission impacts of E15 on motor vehicles spanning a range of model years, including several Tier 2 motor vehicles. Growth Energy claims that the ACE Study[46], the RIT Study, the Minnesota Center for Automotive Research (MCAR) Study, [47] and a DOE Pilot Study show that E15 results in decreased emissions of NOx, non-methane hydrocarbons (NMHC), and

[46] Optimal Ethanol Blend-level Investigation, Final Report prepared by Energy & Environmental Research Center and Minnesota Center for Automotive research for American Coalition for Ethanol "ACE Study". EPA Docket # EPA-HQ-OAR-2009-0211-0002.26.

[47] Use of Mid –Range Ethanol/Gasoline Blends in Unmodified Passenger Cars and Light Duty Trucks, prepared by Minnesota Center for Automotive research July 1999 " MCAR Study" . EPA Docket #EPA-HQ-OAR-2009-0211-0002.24.

CO on average, and no increase in NMOG emissions when compared to E0. Growth Energy argues that these studies demonstrate that E15 will not cause or contribute to the failure of motor vehicles to meet their emissions standards. While much of the data cited by Growth Energy was on E20, they argued that because the studies they submitted with their application show favorable emissions performance on gasoline-ethanol blends that contained higher than 15 vol% ethanol (i.e. E20), those results should be applicable to E15 by interpolation.

b. Public Comment Summary

The Alliance of Automobile Manufacturers ("The Alliance") and several others commented that EPA has repeatedly outlined in past waiver decisions and public presentations important methodological considerations necessary to conduct a rigorous test program which would provide data sufficient to satisfy waiver criteria.[48] Comments from the Alliance describe the data requirements EPA has required in the past, specifically noting that those test programs required the following: (1) use representative test fleets of motor vehicles available in the market; (2) conduct back-to-back motor vehicle pair testing to control for variability; (3) compare test fuel results with a baseline certification fuel; (4) use Federal certification test procedures (FTP) for emissions testing; (5) evaluate emissions effects over the full useful life for durability testing through real-world aging; and (6) perform statistical analyses to provide defensible results. The Alliance went on in their comments to highlight deficiencies in one or more of these data requirements in each of the studies cited by Growth Energy.

[48] See Alliance of Automobile Manufacturers Comments, National Petrochemical and Refiners Association, the American Petroleum Institute's Comments, and the Alliance for the Safe Alternative Fuels Environment comments in EPA Docket #EPA-HQ-OAR-2009-0211.

Additionally, the Alliance and others argue that none of the studies submitted by Growth Energy used nationally "representative" test fleets. The Alliance points out that the American automobile fleet takes about 20 years to turn over, and that a well-executed study should have a test fleet that is proportionally similar to the model years that comprise the national fleet. The Alliance argues that a bulk of the emissions data cited in Growth Energy's waiver request focus on newer (i.e., Tier 2) motor vehicles and do not adequately represent the national motor vehicle fleet and that these older motor vehicles may be more sensitive to the effects of higher gasoline-ethanol blends and constitute a greater portion of the number of motor vehicles currently in use. Many comments recommend that the Agency deny Growth Energy's request based on the potentially adverse effects of E15 on older motor vehicles.

Several commenters, including the automobile manufacturers, petroleum refiners, environmental organizations and state agencies, noted the expected linear relationship between ethanol content in gasoline-ethanol blends and increased NOx emissions. These commenters pointed out that the EPA Predictive Models, MOVES model and the MOBILE6.2 model all predicted increased NOx emissions as a gasoline-ethanol blend increases the ethanol content. These models are used for air quality modeling purposes for compliance with state and federal air quality standards and are based on comprehensive motor vehicle testing spanning decades. These commenters argued further that these increases in NOx may cause a sizable portion of the motor vehicle fleet to exceed emissions standards, especially if a motor vehicle was close to the emissions standard.

c. EPA Analysis

The Agency agrees with commenters that there are several limitations of the studies cited by Growth Energy and/or the analyses they performed, which undermine their conclusions. The ACE study cited by Growth Energy does not provide useful information to assess the emissions performance of motor vehicles for purposes of this waiver decision since it tested three non-flex fuel Tier 2 motor vehicles primarily under high-speed and high-load conditions, atypical of most in-use motor vehicle operation and not representative of motor vehicle certification conditions. The study likely shows that the high heat of vaporization and high octane of ethanol can enhance vehicle performance under wide-open throttle conditions and high loads, but the Agency believes that it is not relevant for evaluating emissions under normal operating conditions as observed on properly loaded motor vehicles tested on certification test cycles generally required for a waiver emission impacts demonstration.

The RIT Study cited by Growth Energy was an interim report of ongoing work in which E0 and E20 fuels were tested in 10 1998-2004 model year motor vehicles from the Monroe County Fleet Center, none of which were designed to comply with Tier 2 emission standards. The emissions testing performed at the time of Growth Energy's application failed to properly measure emissions related to the ethanol (i.e., alcohols and aldehydes) which contribute to the NMOG emissions. Furthermore, the testing schedule did not perform back-to-back testing of the different fuels at common motor vehicle mileage intervals, thus confounding fuel and normal deterioration effects. As discussed below, we believe these shortcomings were subsequently corrected in later testing through the support of the NREL, but the data cited by Growth Energy could not be used to quantify the immediate emissions impacts of E15.

The MCAR Study cited by Growth Energy tested 15 motor vehicles of various model years from 1985 to 1998. However, the emissions were measured over only a hot portion of the certification cycle and the individual test results needed for analysis were never submitted or made available to the Agency. Therefore, it could not be used to compare the emissions performance of the motor vehicles to the emissions standards. Furthermore, since only E10 and E30 were tested, it cannot be used to quantify the immediate emission impacts relative to the official E0 certification fuel.

Only the DOE Pilot Study cited by Growth Energy provides useful information for assessing the immediate exhaust emission impacts of E15. It measured emissions from 16 vehicles, including seven Tier 2 compliant motor vehicles, on E0, E10, E15, and E20 splash blends over the LA92 drive cycle. However, even it is of limited usefulness in drawing conclusions regarding the impact of E15 across the large in-use motor vehicle fleet due to the limited size and nature of the test program (fleet makeup, test fuels). The DOE Pilot Study was not designed to quantify the emissions impact across the fleet but instead to probe a limited sample of high sales volume motor vehicles certified to different emission standards for any immediate emission problems. By itself, it is not a basis for drawing any definitive conclusions with respect to E15 emissions performance.

Thus, each of the individual studies is of limited value in evaluating the immediate emissions impact of E15 across the various groups of motor vehicles at issue in this partial waiver decision. As a group, these studies are no stronger as they do not fill the gaps in each of the various studies. Therefore, the Agency does not believe that the studies submitted by Growth Energy adequately support the conclusions that Growth Energy drew from them regarding the immediate exhaust emission impacts from using E15. At the same time, the Agency believes that there is sufficient data and information available to demonstrate that the immediate emissions impact of E15 follows the same pattern as E10 in that there will be a decrease in NMOG (as well as NMHC and total HC) and CO emissions and an increase in NOx emissions. While the magnitude of the NOx emissions increase is greater with E15 it is still not enough to cause at least Tier 2 compliant motor vehicles to violate their NOx emissions standard.

There is a long history of test programs that have been carried out on light-duty motor vehicles and trucks that have quantified the emission impacts of blending ethanol up to 10 vol% into gasoline. These test programs, dating back to the earliest days of gasoline-ethanol blends, have found that the oxygen content of ethanol enleans the A/F ratio in motor vehicles during open-loop operation, causing a decrease in HC and CO emissions, but also results in a corresponding increase in NOx emissions. These test programs have also shown that during normal closed-loop operation the combustion characteristics of ethanol contribute to small increases in NOx emissions. There are other factors that can play into the emission impacts, such as other changes to gasoline that occur or are made when ethanol is added, the high heat of vaporization and high octane of ethanol, and the design and control algorithms of the motor vehicle. However, similar emission trends with ethanol have been seen consistently in most carefully controlled and properly conducted studies. These studies have been used to develop emission models, such as the EPA Predictive Models[49] incorporated into the Agency's MOVES model,[50] that have been thoroughly peer reviewed. The result is that for a typical E10 blend of gasoline, exhaust NMHC emissions have been found to decrease by about 5%, and NOx emissions to increase by about 6%, relative to E0.[51] While the magnitude of impact may vary by a few percent depending on the motor vehicle technology and how other fuel properties change when ethanol is blended into gasoline, the relative magnitude and direction of the impacts remains consistent for typical fuels.[52]

While there is a great deal known about the immediate impacts of gasoline-ethanol blends on emissions from the past studies and modeling, it is all based on pre-Tier 2 motor vehicles and only ethanol blends up to E10. The issue for the waiver is whether the impacts of E15 would be significantly different in comparison to E0 and cause motor vehicles to violate their emission standards over their full useful life, and whether there is sufficient information to support such a conclusion for Tier 2 motor vehicles as well as other motor vehicles. While the information provided by Growth Energy was of limited value, we believe that the additional information that is now available can be used to assess the immediate emissions impacts on Tier 2 motor vehicles sufficiently to respond to the E15 waiver request.

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[49] A detailed description of the development of the EPA Predictive Models is available in a Technical Support Document: "Analysis of California's Request for Waiver of the Reformulated Gasoline Oxygen Content Requirement for California Covered Areas", EPA420-R-01-016, June 2001.

[50] The Agency's MOVES model has undergone extensive peer review and testing, and incorporates the EPA Predictive Models.

[51] These effects are based the EPA Predictive Models and are generally consistent with conclusions of CRC E-74b report (e.g., Figure ES-2). Fuels properties evaluated were based on market averages and were as follows. Other parameters not mentioned here were assumed to be held constant between the blends.

Blend Level	**Aromatics (vol%)**	**T50 (dig's)**	**T90 (dig's)**	**RVP (psi)**
E0	29.5	215	325	8.9
E10	24.9	202	325	8.9

[52] Results based on data mostly from vehicle models that predated the Tier 2 emission standards, so several recent test programs have been focused on Tier 2 vehicles that will soon make up the majority of the in-use fleet.

CRC recently completed a test program (E-74b) that evaluated the emissions performance of E10 and E20 compared with E0 ("CRC Emissions Study").[53] The study tested 15 MY1994-2006 motor vehicles on E0, E10, and E20. The motor vehicles represented a cross-section of several motor vehicle technologies and emissions compliance levels, and included three Tier 1, five NLEV, and seven Tier 2 motor vehicles. The test fuels were match-blended to yield appropriate test program volatility goals while attempting to maintain other desired property targets, such as aromatics content and distillation behavior. The study's authors attempted to evaluate increased oxygen levels through the blending of ethanol in a variety of gasolines with fuel parameters representative of those found in the real world. Emissions performance testing was completed using the FTP at 75 °F and 50 °F. The study found a statistically significant positive linear relationship between the amount of ethanol blended into gasoline and NOx emissions when controlling other fuel parameters. In other words, as the level of ethanol blended into gasoline increased, the amount of NOx emissions also increased, and this effect remained relatively consistent across the motor vehicle technologies tested. Specifically, the study found that NOx emissions increased with E10 by about 9% relative to E0, consistent with the projection from the EPA Predictive Models when the study's fuel properties are input. NOx emissions for E20 increased by about 19% relative to E0. The test program also found that HC emissions declined from 8% to 16% over this same range. While not linear, a relationship of decreasing emissions with increasing ethanol content was also observed for CO emissions. Presumably the impacts of E15, had they tested it, would have fallen somewhere between those of E10 and E20.

[53] CRC Report No. E-74b, "Effects of Vapor Pressure, Oxygen Content, and Temperature on CO Exhaust Emissions", May 2009, EPA Docket #EPA-HQ-OAR-2009-0211-13980.

The DOE Pilot Study cited by Growth Energy tested 16 different MY1999-2007 light-duty motor vehicles on E0, E10, E15 and E20. These motor vehicles included three Tier 1, six NLEV, and seven Tier 2 motor vehicles of varying odometer mileage, generally proportional to age (i.e., older motor vehicles had higher miles). Test fuels were splash blended with the certification E0 fuel allowing the other fuel properties (aromatic content, RVP, etc.) to change with ethanol dilution. The motor vehicles were tested over the LA92 drive cycle (also known as the Unified Cycle) which is considered to be representative of real-world acceleration rates and speeds.[54] The study found small reductions in NOx and NMOG emissions across the different fuels that were not statistically significant. While these findings do not show the NOx emissions increase and NMOG and CO emissions decrease that might be anticipated, this may have been due to the limited scope of the program, the test cycle, and other changes in the fuel properties known to directly impact emissions. Nonetheless, the results do not show that the immediate NOx emissions impacts of E15 to be of concern.

During the course of the DOE Catalyst Study (see Section IV.A.1.d), some back-to-back tests of E15 and E0 fuels were performed. This portion of the testing was not designed to be able to quantify the immediate emission impacts with any degree of statistical confidence unless the impacts turned out to be very large, and in fact it did not show any statistically significant changes in NOx or NMOG emissions for E15 compared to E0. At the same time, the data is

[54] The Alliance commented that only the FTP test cycle should be used for emission impacts. While the LA92 cannot be used for confirmation of vehicle emissions compliance, it is used regularly in engineering and research work, including by manufacturers to measure emission impacts and confirm OBD monitor operation and therefore the Agency believes it remains a valid cycle for emissions analysis.

useful in supporting the conclusion that the immediate emission impacts of E15 compared to E0 are not large, and likely in the same range as other studies have shown.

Finally, as mentioned above, RIT performed additional testing subsequent to the results Growth Energy submitted as part of its waiver request application. These later results were presented at a meeting of the Mid-Level Ethanol Blends Research Coordination Group on May 5, 2010.[55] These results showed a 13.9% reduction in HC (NMOG was not measured), 26.9% reduction in CO, and a 6.2% increase in NOx for E20 in comparison to E0. Again, presuming E10 and E15 results would lie within this range, these results are generally consistent with earlier studies and models and continue to confirm that no large increases in NOx emissions are expected.

When EPA assesses the more recent information and data available, we believe it shows both: (1) that Tier 2 motor vehicles exhibit similar immediate emission impact trends (small increases in NOx and small decreases in NMHC and CO) as the data and modeling show for older motor vehicles; and (2) that the immediate emission impacts of E15 continue to show the same trends as E10 with the effects being slightly exaggerated due to the higher ethanol content. These four studies (CRC E74b, the DOE Pilot Study, the DOE Catalyst Study, and the RIT Study) are all of limited size and scope and thus show considerable variation in their results, for NOx emissions in particular. However, taken together they suggest that the immediate emission impacts of E10 are likely to be comparable to those that would be projected using the EPA Predictive Models and that a slightly larger NOx emission impact would be expected with E15.

[55] RIT-CIMS/USDOT E20 Test and Evaluation Program May 2010, EPA Docket #EPA-HQ-OAR-2009-0211-14003.8.

Thus, the NOx emissions impact of E15 is likely to be in the range of 5% to 10% based on extrapolation from E10 modeling using the Agency's Predictive Models, and this impact would be expected to be roughly comparable for newer Tier 2 motor vehicles as well as older motor vehicles. For example, a Tier 2 motor vehicle that had NOx emissions levels of 0.030 grams per mile ("g/mi") on E0 would be expected to have NOx emissions levels of 0.033 or less if the same motor vehicle was tested on E15.

Although the overall weight of the available data shows that E15 will cause an increase in NOx emissions, the issue is whether such increases, by themselves or in combination with long-term durability effects, would cause motor vehicles to exceed their certified emissions standards. Given the relatively small magnitude of the immediate NOx emissions increase in relation to the large compliance margins that motor vehicle manufacturers have traditionally built-in to the products they certify,[56] and the lack of any significant increase in NOx emissions deterioration with E15 in comparison to E0 (as discussed in section IV.A.1.a.), it is not anticipated that using E15 will cause or contribute to Tier 2 compliant motor vehicles exceeding their emissions standards.

A survey of official EPA Certification data showed that the average compliance margins for the MY2007 light-duty motor vehicle fleet was over 50% for NOx emissions.[57] This margin is designed into motor vehicles by the manufacturer to account for variations in production vehicles and changes to the motor vehicle during actual field usage. Additionally, data collected

[56] A compliance margin is the difference between the emission standard and a vehicle or engine's actual certification emission level. This certification level includes the manufacturer's projected rate of deterioration over the useful life of the vehicle.
[57] See *2007 Progress Report: Vehicle and Engine Compliance Activities*. These compliance margin values are consistent with the general trend EPA has seen for Tier 2 vehicles.

from EPA's In-use Verification Program (IUVP) demonstrate large compliance margins for motor vehicles operating in real-world conditions. IUVP is a manufacturer run program in which manufacturers test motor vehicles for emissions levels and submit the results to EPA. IUVP was designed to ensure that light-duty motor vehicles are meeting emissions standards in-use versus only through the certification process. According to the data submitted to EPA, the in-use compliance margins are similar to compliance margins experienced during certification. For IUVP testing for MY2007 as of August 2010, the average compliance margin for light-duty motor vehicles certified to the Tier 2 Bin 5 standard was over 60%.[58]

In addition, the results of the recently completed DOE Catalyst Study also supports this conclusion for Tier 2 motor vehicles. While the Catalyst Durability Test Program was carried out to assess long-term exhaust emissions (durability) impacts, the immediate emission impacts of ethanol are also captured in the testing. All but two of the Tier 2 motor vehicles tested continued to comply with their exhaust emission standards at FUL despite both the immediate and durability impacts of E15 on emissions. One motor vehicle appeared to exceed the standard not due to E15, but other problems, as it also exceeded the standard on E0. The other motor vehicle model experienced catastrophic issues with the comparable E0 and E20 motor vehicles which were unable to complete the testing. Those motor vehicles that complied with the standard on E15 continued to comply as is typical in IUVP data.[59]

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[58] Tier 2 Bin 5 is the certification standard for a large majority of vehicles certified in MY2007 (approximately 80%). See *2007 Progress Report: Vehicles and Engine Compliance Activities.*

[59] EPA, in collaboration with DOE and CRC has recently completed the testing part of the largest fuels emission research program conducted in the past two decades to assess the impacts of gasoline fuel properties on emissions, including the relationship between ethanol content and higher NOx emissions. E-89 "Comprehensive Gasoline Light-duty Exhaust Fuel Effects Test Program." The test program evaluated emission changes on a motor vehicle test fleet consisting of 15 Tier 2 vehicles (including three FFVs) that was specifically selected to be representative of the makes and models in the national light-duty motor vehicle fleet. The focus was on Tier 2 vehicles to fill a data gap, since existing emission models are based on testing conducted on older technology vehicles. The program used

d. Conclusion

While data is limited on Tier 2 motor vehicles, and particularly with E15, there is a long history of test programs that have been carried out on light-duty motor vehicles and trucks that have quantified the immediate emissions impacts of blending ethanol into gasoline. The common theme across these various test programs is that, consistent with combustion theory, the enleanment of the A/F ratio caused by the oxygen in ethanol leads to an immediate reduction in HC and CO emissions and a corresponding increase in NOx emissions. While other factors influence this, such as the combustion characteristics of the ethanol itself, other changes that occur in the gasoline when ethanol is added, and the test conditions under which the emissions are measured, cause some variations in study results, the bottom line is that the emissions changes are fairly well known. Several more recent studies have been performed looking at the impacts of gasoline-ethanol blends on more recent Tier 2 compliant motor vehicles, as well as some older model year motor vehicles. The size, scope, and design of these studies limit the ability to draw any firm conclusion to quantify the precise magnitude of the immediate emissions impacts. However, analysis of this more recent data in the context of historical data and modeling leads to the conclusion that Tier 2 motor vehicles likely respond similarly to older

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27 fuels of varying volatility (RVP), aromatic content, distillation range (T50 and T90) and ethanol concentrations (E0, E10, E15 and E20), which were blended specially to allow emission impacts to be attributed to one fuel parameter or another. Each vehicle in the test program had multiple emissions tests conducted on each fuel resulting in nearly 1000 emissions tests. While testing has been completed, the Agency is still in the process of working with DOE and CRC to evaluate the test data and develop emission models based on it to allow an understanding of the impacts of fuel changes on emissions. However, since the evaluations of the data have not been completed and the data is not publicly available, EPA is not relying on the data for purposes of evaluating the waiver request. EPA has reviewed the data preliminarily solely to determine whether it would be appropriate to delay making a decision until the evaluation is complete and the test program results could be incorporated into a decision on the waiver. EPA's view based on its preliminary review of the data is that it is appropriate to go forward at this time with the waiver decision, as it is anticipated that the test program will reinforce the results found in the earlier studies and in the EPA Predictive Models.

technology motor vehicles with respect to immediate emissions impacts, and that the magnitude of the immediate emissions impacts of E15 are relatively small, with decreases in NMHC and CO emissions and increases in NOx emissions in the range of 5 to 10% depending on how other fuel properties change. For Tier 2 motor vehicles, there is generally a significant margin in both motor vehicle certification and in-use to emit within the emission standards even if the motor vehicle experiences the predicted immediate NOx increases from E15 when compared to E0.

The Agency believes that the data above, coupled with the average compliance margins, are sufficient to show that the immediate exhaust emissions effects by themselves would not cause motor vehicles to exceed their exhaust standards over their useful lives. As discussed earlier, however, whether the fuel or fuel additive will cause motor vehicles to exceed their exhaust emission standards requires consideration of the combined impact of immediate emissions increases and the long-term exhaust emissions (durability) effects.[60]

3. <u>Evaporative Emissions on MY2007 and Newer Light-duty Motor Vehicles</u>

a. Introduction

EPA has set evaporative emission standards for motor vehicles since 1971. During the ensuing years, these evaporative standards have continued to evolve, resulting in additional

[60] Separately, the Agency has been performing analysis needed to support the anti-backsliding analysis required under the Energy Independence and Security Act. We are now in the process of assessing possible control measures to offset the potential increases in ozone and particulate matter that are expected to result from the increased use of renewable fuels required by EISA and in response to the May 21, 2010 presidential memorandum directive. (NOx emissions contribute to the formation of both pollutants.) We will incorporate the results of our analysis under this assessment in a proposal on new motor vehicle and fuel control measures.

evaporative emissions reductions. Thus, consideration of the impact of E15 on evaporative emissions compliance requires consideration of the applicable evaporative emissions standards to which the particular motor vehicles were certified. There are now five main components to motor vehicle evaporative emissions that are important for our standards: (1) diurnal (evaporative emissions that come off the fuel system as a motor vehicle heats up during the course of the day); (2) hot soak (evaporative emissions that come off a hot motor vehicle as it cools down after the engine is shut off); (3) running loss (evaporative emissions that come off the fuel system during motor vehicle operation); (4) permeation (evaporative emissions that come through the walls of elastomers in the fuel system and are measured as part of the diurnal test); and (5) unintended leaks due to deterioration/damage that is now largely monitored through onboard diagnostic standards.

Prior to MY1999, the evaporative emissions standards addressed diurnal and hot soak emissions, but the test procedure did not require control of running loss and permeation emissions. The Enhanced Evaporative Emissions requirements were fully phased in for light-duty motor vehicles and light-duty trucks by MY1999. These new requirements included both new standards and new test procedures: the two-day and three-day diurnal tests with new canister loading procedures, and a running loss test. In addition to the new procedures, the useful life was extended from 5 years/50,000 miles to 10 years/100,000 miles for light-duty motor vehicles.

Along with the Enhanced Evaporative Emissions requirements, EPA introduced the On Board Diagnostic (OBD) requirements for evaporative leak detection monitors. This required motor vehicles to detect a leak equivalent to .040 inch in the fuel or evaporative emissions system. Beginning in MY2001, EPA allowed manufacturers to comply with California OBD regulations which required motor vehicles to detect a leak equivalent to a .020 inch. While not required federally, many manufacturers developed one leak detection system for sale in all 50 states which complied with the more stringent California requirement.

The Federal Tier 2 evaporative emissions standards[61] were phased in beginning in 2004 with the exhaust standards and were fully phased in by 2007 for light-duty motor vehicles (2009 for HLDT and MDPV). These standards were significantly lower (over a 50 % reduction for LDVs and LLDTs – as seen in Table 1 below) and used the same test procedures, which were introduced with the Enhanced Evaporative Emissions requirements. However, one important change was made in that a demonstration of evaporative system durability on E10 was required to address concerns with respect to permeation of hydrocarbons through elastomers in the fuel and evaporative emission systems. This prompted manufacturers to change materials to those with improved permeation barriers with ethanol. Once again in 2009 the evaporative emission standards for LDVs were cut nearly in half with the introduction of the Federal LEV II requirements, a harmonization of Federal and California evaporative standards. See Table IV.A-4 below. This section discusses the evaporative emissions impacts on MY2007 and newer light-duty motor vehicles. Discussion of evaporative emission impacts on older motor vehicles is addressed in sections IV.B. and IV.C. However, since the information we received through Growth Energy's waiver request application, information supplied by commenters, and other available information regarding evaporative emission impacts of ethanol blends were not specific

[61] This Decision refers to several vehicle types as commonly used acronyms: light-duty motor vehicles (LDV), light-duty trucks (LDT), light light-duty trucks (LLDT), heavy light-duty trucks (HLDT), and medium-duty passenger vehicles (MDPV). *See* "Vehicle Weight Classifications" found at: http://www.epa.gov/otaq/standards/weights.htm.

to the model year of the motor vehicles, this section also contains some of the information covering older motor vehicles as well.

Table IV.A-4 Federal Evaporative Emissions Standards from 1999 to Present

EVAP Emission Standards at full useful life	3 day diurnal + hot soak*		2 day diurnal + hot soak*		Running Loss	Useful life Mi or yrs
	LDV and LLDT 1,2	Truck LDT3, LDT4	LDV and LLDT 1,2	Truck LDT3 LDT4	LDV and LDT	
Enhanced Evap 1999 to 2008 (HLDT only in 2008)	2.0 g/ test	2.0 (< 30 gal) 2.5 (> 30 gal)	2.5 g/ test**	2.5 (< 30 gal) 3.0 (> 30 gal)	0.05 g/ mi	10 yr 100k mi LDV/LDT1,2 11 yrs 120 K LDT3,4
Tier 2 2007 to 2009 (HLDT only in 2009)	.95 g/ test	1.2 g/ test	1.2 g/ test	1.5 g/ test		10 yr 120k mi
LEV II Near Zero Evap	.50 g/ test LDV .65 g/test LDT1,2	.90 g/ test	.65 g/ test LDV .85 g/test LDT1,2	1.15 g/ test		10 yr-120k mi Fed 15 yr-150k mi Cal

* The standard is based on the sum of the highest single day diurnal and the hot soak measurements.
**3.0 g/ test for LDT2 beginning in 2001

b. Growth Energy's Submission

Growth Energy primarily argued that based on the similar volatility and permeation characteristics of E15 to E10, the evaporative emissions for motor vehicles using E15 should be no worse than those from motor vehicles using E10. Growth Energy pointed to two studies to support this conclusion. The first study cited was the E-65-3 study on permeation conducted by the CRC.[62] The E-65-3 study measured the impact of E6, E10, E20, and E85 gasoline-ethanol blends on permeation and diurnal canister breakthrough emissions in comparison to E0 on test rigs taken from five MY2000-2005 California motor vehicles. The testing was performed on California fuels using California test procedures.

The second study cited was completed by the University of Stockholm for the government of Sweden to investigate the potential effects that increased ethanol levels blended into gasoline may have if approved for use in Sweden ("Stockholm Study").[63] The Stockholm Study is primarily a literature review that includes studies and experiences with gasoline-ethanol blends in several countries (e.g. Brazil, the Netherlands, and Australia). As part of the Stockholm Study, a small test program compared vapor generation rates from two summer-time gasoline fuels blended with ethanol at contents of zero, five, 10, and 15 vol%. The Stockholm Study found that the impact of ethanol on the RVP of gasoline blends peaked somewhere between E5 and E10, consistent with past studies.

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[62] CRC Report No. E-65-3, *Fuel Permeation from Automotive Systems: E0, E6, E10, E20 and E85 Final Report*, December, 2006. EPA Docket #EPA-HQ-OAR-0211-14012.
[63] Growth Energy Request Letter – Tab 4, 1st half, EPA Docket #EPA-HQ-OAR-2009-0211-0002.12.

Other than cross-referencing materials compatibility testing, Growth Energy did not address the potential impacts of E15 on evaporative emissions durability, hot soak and running loss emissions, or fuel system integrity (leaks as monitored by the OBD system) to assess noncompliance with the evaporative emissions standards. Growth Energy simply used these two studies to argue that the evaporative emissions of E15 will be lower or no worse than E10 or E6. They argued that since the CRC Permeation Study and the Stockholm Study show no increases in evaporative emissions between E10 and E15, that materials compatibility testing showed no problem, and that if EPA can place a condition requiring finished fuels to meet ASTM volatility specifications, evaporative emissions criteria for a waiver are satisfied.

c. Public Comment Summary

Several commenters point to design flaws and limitations with both the Stockholm Study and CRC Study which underscore the need for more investigation into E15's impact on vehicles' evaporative emissions. API and others argue that the fuels used in the Stockholm Study's evaporative emissions test program do not resemble fuels produced and used in the United States. API argues that RVP of the base fuels tested in the program are relatively high in comparison to summertime non-ethanol fuels used in the US (9.14 and 10.15 psi). API also argues that since the test program did not complete the evaporative emissions testing in the VT-SHED with actual vehicles and did not utilize the EPA approved Federal Test Procedure, it would be difficult to determine what the actual emissions results for E15 would have been under real world conditions.

Similarly, many commenters noted limitations and concerns with the CRC E-65-3 permeation study cited by Growth Energy. The study did not evaluate evaporative emissions from entire motor vehicles, but rather from test rigs set up specifically to study permeation rates with various gasoline-ethanol blends. While the study also measured diurnal emissions by measuring breakthrough of the canister, it did so only using very low RVP fuels that met California's reformulated gasoline standards. Further, the test rigs were uniquely configured for precise permeation measurement and not for a quantitative assessment of vapors from canister breakthrough.

Several commenters allude to the fact that Growth Energy provided no analysis of how evaporative emissions control systems will behave over the full useful lives of motor vehicles. The New York Department of Environmental Conservation ("NYDEC") expressed in particular their concern that full useful life testing is needed since E15 could cause increased water absorption which in turn may lead to decreased canister capacity and evaporative emissions breakthrough of the canister.

Several comments noted that Growth Energy often compares performance results of E15 to E10 rather than E15 to certification fuel (E0) to satisfy waiver criteria. AllSAFE and the Alliance both suggest that EPA has a legal obligation to only consider comparisons of E15 to certification fuel. AllSAFE argues that EPA has required that CAA section 211(f)(4) waiver requests compare the test fuel with certification fuel over the past 30 years, and that comparing E15 to E10 would be making a comparison between two fuels that are not "substantially similar" to certification fuel. AllSAFE continues by arguing that allowing comparisons to fuels that have been granted waivers rather than a comparison to fuels that are substantially similar to certification fuels may allow for "incremental creep" that might mask emissions effects of new fuels or fuel additives.

d. EPA Analysis

Growth Energy's conclusions with respect to evaporative emission impacts are not adequately supported by the evidence they submitted. They did not provide any test data of in-use motor vehicles showing that they continued to meet their evaporative emission standards over their full useful life, but rather provided only limited information to address these concerns. The Stockholm Study they cited cannot be used to assess actual motor vehicle emission performance in comparison to their standards, but rather simply quantifies the potential increase in vapor generation rates (fuel volatility) for various gasoline-ethanol blends. Increased vapor generation may result in increased motor vehicle emissions, but one needs to evaluate this in the context of evaporative emissions control systems on actual motor vehicles.

The CRC E-65-3 permeation study cited by Growth Energy did not evaluate evaporative emissions from entire motor vehicles, but rather from test rigs set up specifically to study permeation rates with various gasoline-ethanol blends. This study measured diurnal using only very low RVP fuels that met California's reformulated gasoline standards. As a result, it cannot be used to assess the impact on diurnal emissions of higher volatility fuels. However, perhaps the most important limitation of this study is simply that it was a predecessor to much more comprehensive studies not addressed by Growth Energy (E-77, E-77-2, E-77-2b, E-77-2c)[64] into the permeation and evaporative emission impacts of various gasoline-ethanol blends that grew out of the original E-65-3 study.

In addition to these study limitations, perhaps the most important concern is that Growth Energy failed to use the available information to perform the correct comparison. To grant a waiver for a fuel or fuel additive under CAA section 211(f)(4), it must be shown that motor vehicles will continue to meet their evaporative emission standards over their full useful life. Short of actual test data on motor vehicles demonstrating this, the evaluation of the potential emissions impacts must compare motor vehicles using the new fuel or fuel additive to their emissions performance on the fuel they were certified on, in this case E0. Instead, when considering the potential permeation and diurnal emission impacts, Growth Energy only drew their conclusion for E15 relative to E10 and E6, which themselves have been demonstrated in the CRC studies to cause elevated permeation and diurnal emissions.

Growth Energy also failed to address potential long-term evaporative emission durability concerns in any meaningful way, referencing only the materials compatibility work discussed in section IV.A.4.

Despite the limitations of the Growth Energy petition with respect to vehicle evaporative emissions, the Agency believes that sufficient information is available through other studies to support the conclusion that as long as E15 meets a summertime gasoline volatility level of no higher than 9.0 psi, Tier 2 compliant motor vehicles—which includes all MY2007 and newer

[64] These studies are available at http://www.crcao.org.

gasoline-fueled light-duty motor vehicles and trucks, and medium-duty passenger vehicles—are expected to continue to comply with their evaporative emissions standards on E15.

By virtue of testing of motor vehicles with gasoline-ethanol blends for more than three decades, it is known that gasoline-ethanol blends can have negative impacts on evaporative emissions when compared to E0 on which the motor vehicles are certified. Ethanol impacts diurnal emissions primarily through its impact on the volatility of the gasoline-ethanol blend, boosting the RVP of the final gasoline-ethanol blend by approximately 1 psi unless the gasoline blendstock is produced to offset the increase. Permeation emissions through elastomers in fuel tanks, lines, valves, and connectors have been shown to be strongly influenced by the presence of ethanol in the fuel, though the Tier 2 standards have minimized this impact for Tier 2 compliant motor vehicles. Hot soak and running loss emissions will change in chemical composition with gasoline-ethanol blends and could be impacted over the long term by impacts of ethanol on motor vehicle component materials. Ethanol is also known to cause degradation of certain materials that have been used in motor vehicle gasoline and evaporative emission control systems that could lead to increased evaporative emissions over time. As a result of the changing emission standards and motor vehicle designs over the years, these impacts of ethanol on evaporative emissions will vary depending on the age of the motor vehicle. The discussion which follows is focused on the impact on Tier 2 motor vehicles.

For hot soak and running loss emissions, E15 should not impact compliance with the evaporative emissions standards (see Figures 1 and 2). Data from the CRC E-77 test programs suggest that there may be some correlation between hot soak and running loss[65] emissions and ethanol content, but the impact is small, of questionable statistical significance, and may be related to permeation that occurs during the testing (see Figures IV.A-1 and 2).

Figure IV.A-1. Hot Soak Emissions

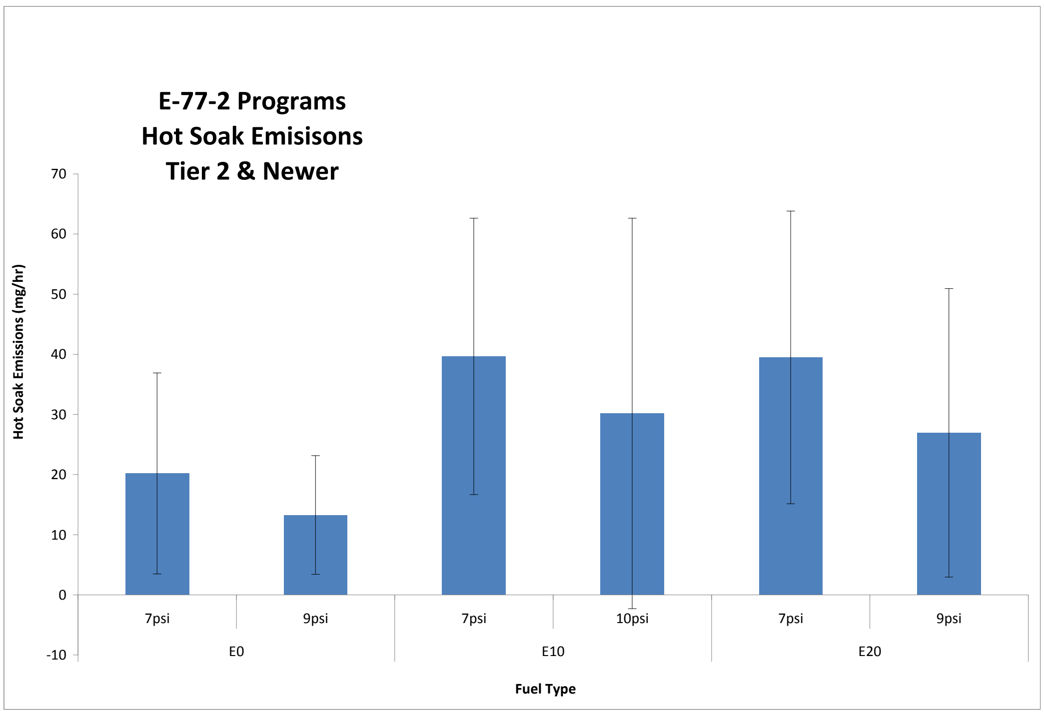

Figure IV.A-2. Running Loss Emissions

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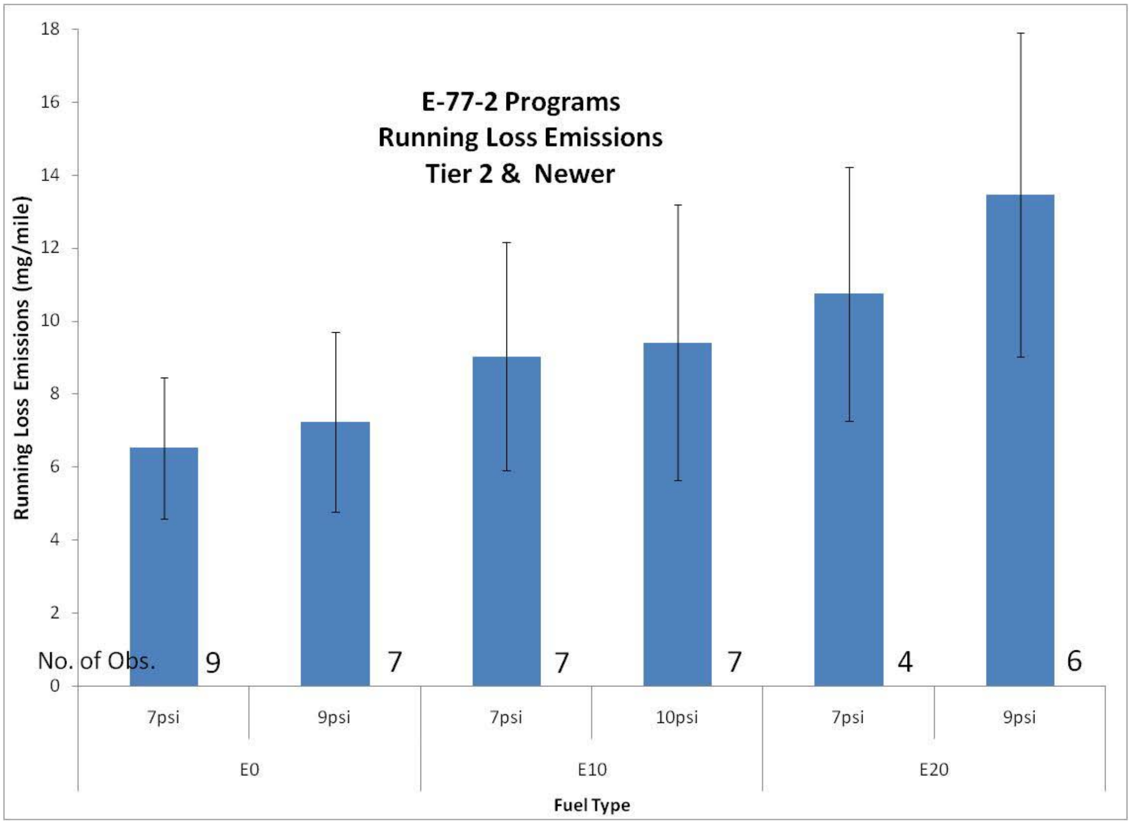
[65] Running loss emissions measured in the E-77 programs did not use the certification cycle. The study was focused on the worst case for permeation emissions and therefore used back-to-back LA92 cycles to increase the tank temperature with more aggressive driving. The certification cycle uses the NYCC which has many stops and starts, making it more difficult to purge the canister. There was no canister breakthrough measured during running loss tests in the study, therefore the chart in Figure 2 shows the effects of ethanol and RVP on running loss permeation.



The CRC E-77 test programs also support the conclusion that diurnal evaporative emissions with E15 are likely to be comparable to those with E0 at the same RVP. Testing performed on E0, E10, and E20 shows that diurnal emissions are a function of the volatility of the fuel, not the ethanol content. As the volatility of the fuel was increased, the number of motor vehicles which experienced canister emissions breakthrough also increased, with seven of eight Tier 2 motor vehicles experiencing canister breakthrough at 10.0 psi RVP. These elevated diurnal emissions are not unexpected since the increased volatility of 10.0 psi versus 9.0 psi fuel results in roughly a 25% increase in evaporative vapor generation that must be captured by the canister beyond what has been required of manufacturers in motor vehicle certification. Almost any canister breakthrough would be enough to cause Tier 2 motor vehicles to exceed their evaporative emissions standard. However, since these tests were done on a more severe diurnal cycle of 65 ^{o}F – 105^{o}F (California cycle), as opposed to the Federal requirement of 72 ^{o}F – 96 ^{o}F, these test results only serve to highlight the concern that fuel with a higher volatility than 9.0 psi RVP during the summer will lead to motor vehicles exceeding their evaporative emissions standard in-use, but do not demonstrate it. At the same time, the Agency is also not aware of any data that would show that E15 with an RVP greater than 9.0 psi would in fact allow motor vehicles to continue to meet their evaporative emissions standards. Given this lack of data and the significant potential for increased evaporative emissions at higher gasoline volatility levels, the E15 waiver can only be considered in the context of E15 that maintains the same volatility as required of E0 certification fuel. As long as the volatility of the fuel does not exceed 9.0 psi during the summer, diurnal emissions from E15 are not anticipated to cause the motor vehicles to exceed their evaporative emissions standards. In addition to the increased evaporative emissions impacts that would result from allowing E15 to have a higher RVP than E0, as discussed in section X, EPA interprets CAA section 211(h)(4) as limiting the 1.0 psi waiver to gasoline-ethanol blends that contain 10 vol% ethanol, including limiting the provision concerning "deemed to be in full compliance" to the same 10 vol% blends. This interpretation is also consistent with how EPA has historically implemented CAA section 211(h)(4) through 40 CFR 80.27(d), which provides that gasoline-ethanol blends that contain at least 9 vol% ethanol and not more than 10 vol% ethanol qualify for the 1.0 psi waiver of the applicable RVP standard.

While the CRC E-77 test programs were extremely valuable in assessing diurnal emissions, their primary purpose was to allow the quantification and modeling of evaporative permeation emissions separate and apart from other evaporative emissions for E0, E10, and E20.

Some key findings of the test programs were that gasoline-ethanol blends can significantly increase permeation emissions compared to pure gasoline. However, consistent with the results from the E-65-3 test program, it appears that the magnitude of the impact is relatively constant across E6, E10, and E20 blends, i.e., no statistically significant difference. In other words, permeation emissions are a strong function of the presence of ethanol in the gasoline, not a strong function of the concentration within the range tested. Consequently, results for E15 would be anticipated to be comparable to those for E10 and E20. The results of the test program also demonstrate the effectiveness of the Tier 2 evaporative emissions standards at reducing permeation emissions. Based on the test results shown in Figure IV.A-3, the additional permeation emissions caused by the ethanol in E15 relative to results with E0 would appear to add little if anything, given the confidence intervals, to the evaporative emissions measurements of a Tier 2 motor vehicle operating over the Federal test cycle. Given the magnitude of manufacturer's evaporative emissions compliance margins for Tier 2 motor vehicles, as shown in Figure IV.A-4, any increase in permeation due to E15 should not be sufficient to cause Tier 2 motor vehicles to exceed their evaporative emission standards.

Figure IV.A-3. Three day Diurnal Test Permeation Emissions[66]

[66] Permeation here will include some background motor vehicle emissions, such as off-gassing from plastic components. The test procedure excluded canister breakthrough emissions and any refrigerant and methanol windshield washer solvent emissions.

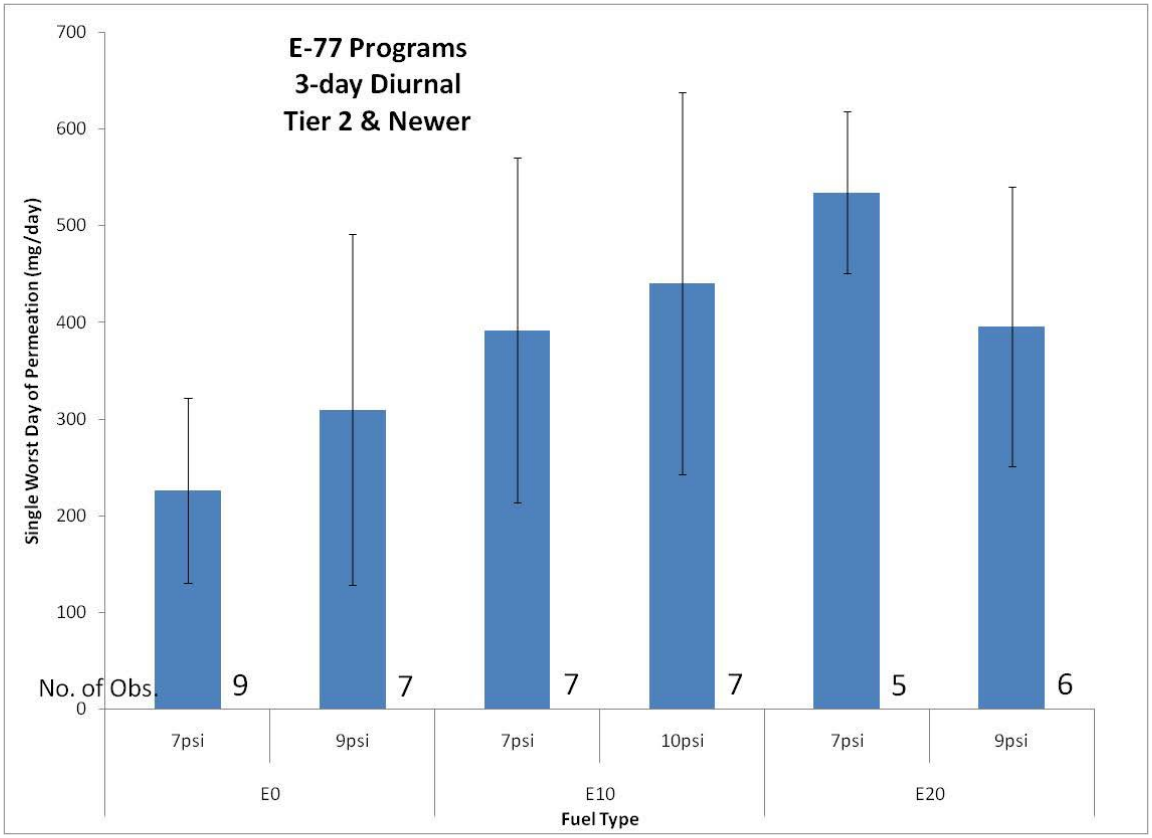
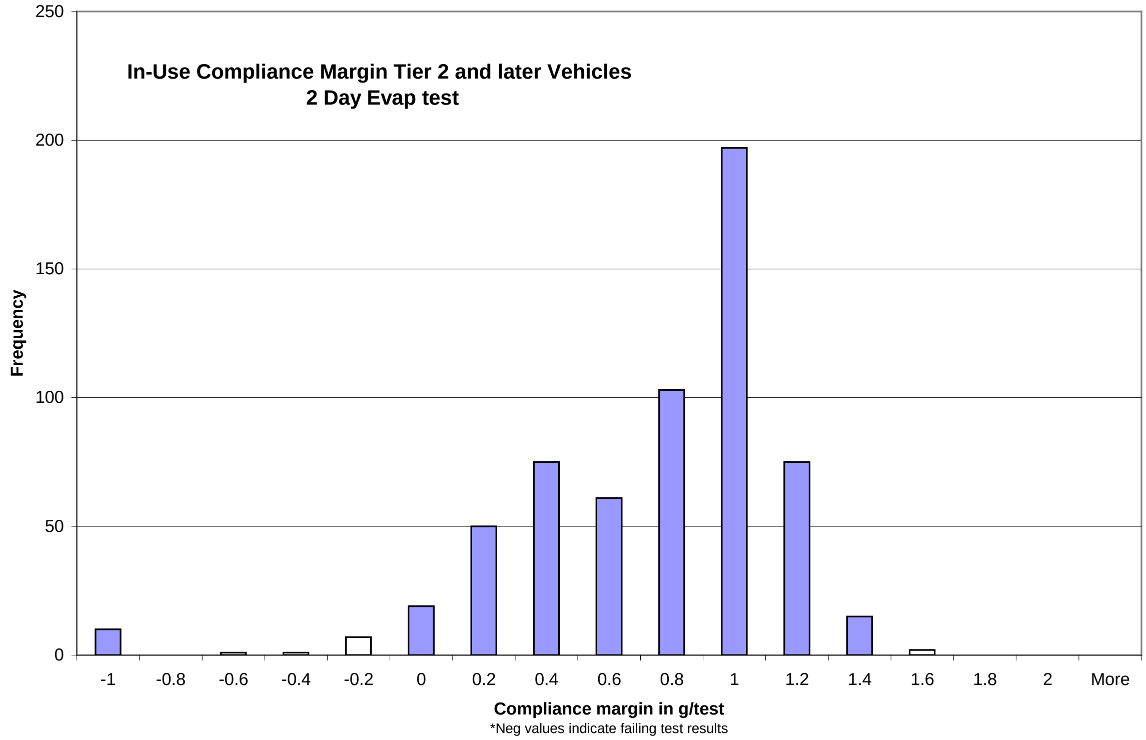

E-77 Programs
3-day Diurnal
Tier 2 & Newer
Single Worst Day of Permeation (mg/day)
700
600
500
400
300
200
100
0
No. of Obs.
9
7
7
7
5
6
7psi
9psi
7psi
10psi
7psi
9psi
E0
E10
E20
Fuel Type

Figure IV.A-4. In-use 2-day Eva Test Compliance Margin Tier 2 and Newer Motor Vehicles[67]



In addition to immediate evaporative emission impacts, Tier 2 motor vehicles' evaporative emissions controls systems were designed for regular E10 use, and they should be compatible and durable with E15 use over the full useful life of the motor vehicle. While they are tested for compliance with their applicable evaporative emissions standards on E0, these motor vehicles are required to demonstrate durability of the evaporative emissions control systems by performing aging with E10; therefore, these motor vehicles must demonstrate that they meet their evaporative emissions standards over their full useful lives after essentially operating exclusively on E10 prior to the certification testing. In other words, the seals,

[67] The two-day evaporative in-use data includes light-duty motor vehicles, light-duty trucks, and MDPVs, with the appropriate standards for each type of motor vehicle given in Table IV.A-4.

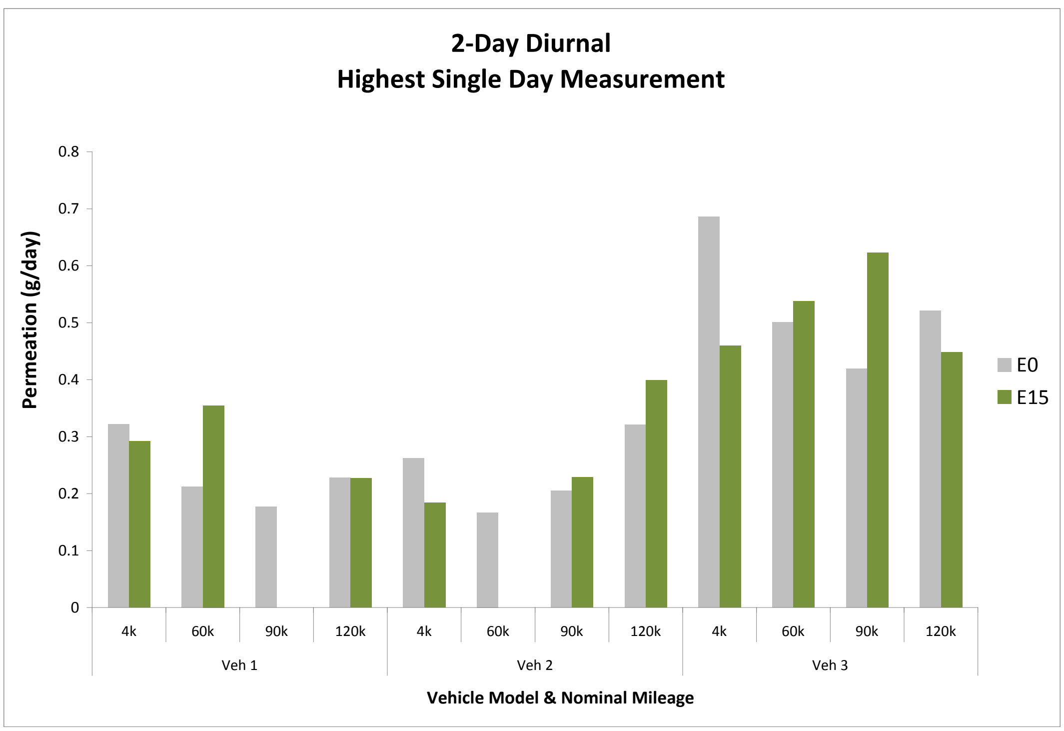
connections and other evaporative and fuel system hardware must be designed to meet evaporative emissions standards over their full useful lives after aging exclusively on E10. In addition to designing them for sustained E10 exposure, these designs must have sufficient design robustness to encompass production variability in materials and tolerances. Robustness in the design of these components should provide the safety margin manufacturers target for volume production. That same robustness is what we believe should allow for durability on E15, and the available test data supports this conclusion.

Testing conducted as part of the DOE Catalyst Study supports the conclusion that Tier 2 motor vehicle evaporative emissions systems should be durable in-use when operating on E15. The program, described above in section IV.A.1, did not show any evidence of evaporative emissions related problems. The onboard diagnostic monitors on the motor vehicles did not set any fault codes for evaporative emission system leaks. Furthermore, no physical differences were found between the impacts of E15 and E0 on motor vehicle components exposed to fuel or fuel vapor during the teardowns of the 12 Tier 2 motor vehicles analyzed (six aged on E0 and six aged on E15).[68] In the same study, one of DOE's contractors performed evaporative emission testing on eight of the Tier 2 motor vehicles (four aged on E0 and four aged on E15) on which they were performing motor vehicle aging and exhaust emission deterioration testing. They performed evaporative emission tests at the same mileage intervals where they measured exhaust emission performance. While this was only a limited sample size, and not directly applicable to Federal certification testing due to the lower RVP of the test fuels, they did not show any greater deterioration in evaporative emission performance over time on E15 compared to E0 (See Figure

[68] Technical Summary of DOE Study on E15 Impacts On Tier 2 Vehicles and Southwest Research Teardown Report. *See* EPA-HQ-OAR-2009-0211.

IV.A-5). While EPA is aware of another ongoing study, AVFL-15, which is looking at the durability of fuel system components, our understanding is that it is performing the testing on E20 using an atypical, "aggressive" ethanol. Consequently, while it may provide useful information for the manufacturers in designing their motor vehicles for the worst case conditions, it would not appear that it would have any bearing on the E15 partial waiver decision being made today.

Figure IV.A-5. Evaporative Testing within DOE Ethanol Total Vehicle Aging Study[69]



[69] The vehicles in this study were not aged over standard evaporative emissions systems aging protocol but rather underwent rapid mileage accumulation. Three vehicles are presented here as the fourth vehicle developed a leak and the data was not comparable for fuel effects.

e. Conclusion

In assessing the potential impacts of E15 on evaporative emissions in their waiver application, Growth Energy did not draw their conclusions by comparing E15 to certification fuel (E0), but rather compared E15 to other gasoline-ethanol blends. In addition, Growth Energy provided only limited information on whether E15 would cause motor vehicles to violate their evaporative emission standards over their full useful lives. In fact, they made only a passing reference to potential evaporative emissions durability impacts of E15. As a result, they did not adequately support their waiver application with respect to evaporative emissions, either immediate emission impacts or long-term durability impacts. However, both evaporative emission testing performed in the CRC E-77 test programs (E-77, E-77-2, E-77-2b, E-77-2c) and limited evaporative emission testing as part of the DOE Catalyst Study support the conclusion that as long as E15 meets a summertime gasoline volatility level of no higher than 9.0 psi, Tier 2 motor vehicles are expected to continue to comply with their evaporative emission standards over their full useful lives when using E15.

4 Materials Compatibility for MY2007 and Newer Light-duty Motor Vehicles

a. Introduction

Materials compatibility is a key factor in considering a waiver request since poor materials compatibility can lead to serious exhaust and evaporative emissions compliance problems not only immediately upon using the new fuel or fuel additive, but especially over time. In most cases one would expect any materials incompatibility to show up in the emissions tests, but there may be impacts that do not show up due to the way the testing is performed or because the tests simply do not capture the effect. As a result, along with emissions testing, materials compatibility is a key factor in assessing the emissions durability of a fuel or fuel additive. This section discusses materials compatibility issues for MY2007 and newer light-duty motor vehicles. However, since Growth Energy's submission and information supplied by commenters regarding immediate emissions impacts of E15 were not specific to the model year of the motor vehicles, this section also contains much of the information and discussion on emission impacts on older motor vehicles that is further discussed in section IV.C.

b. Growth Energy's Submission

Growth Energy submitted a series of studies completed by the State of Minnesota and the Renewable Fuels Association (RFA)[70] that investigated materials compatibility of motor vehicle engines and engine components using three test fuels: E0, E10, and E20 ("Minnesota Compatibility Study"). The Minnesota Compatibility Study looked at 19 metals ("Metals Study"), [71] eight elastomers (rubber materials) ("Elastomers Study"), [72] eight plastics ("Plastics Study"), [73] and 24 common fuel sending unit and fuel pump combinations ("Fuel Pumps Study"

[70] State of Minnesota and Renewable Fuels Association. *The Feasibility of 20 Percent Ethanol Blends by Volume as a Motor Fuel*, EPA Docket #EPA-HQ-OAR-2009-0211-0337.
[71] "The Effects of E20 on Metals Used in Automotive Fuel System Components;" Bruce Jones, Gary Mead, Paul Steevens, and Mike Timanus; Minnesota Center for Automotive Research at Minnesota State University, Mankato; February 22, 2008. EPA Docket #EPA-HQ-OAR-2009-0211-0338.
[72] "The Effects of E20 on Elastomers Used in Automotive Fuel System Components;" Bruce Jones, Gary Mead, Paul Steevens, and Chris Connors; Minnesota Center for Automotive Research at Minnesota State University, Mankato; February 22, 2008. EPA Docket #EPA-HQ-OAR-2009-0211-0002.5.
[73] "The Effects of E20 on Plastic Automotive System Components;" Bruce Jones, Gary Mead, and Paul Steevens; Minnesota Center for Automotive Research at Minnesota State University, Mankato; February 21, 2008. EPA Docket # EPA-HQ-OAR-2009-0211-0002.8.

and "Fuel Pump Endurance Study"),[74,75] currently used in automotive, marine, small engine, and fuel system dispensing equipment for physical or chemical effects due to ethanol.[76] The Compatibility Study concluded that "the effects of 20 percent ethanol blended fuels would not present problems for current automotive or fuel dispensing equipment." While much of the data cited by Growth Energy was on E20, they argued that because E20 showed comparable performance to E10 or E0, E15 should also be comparable by interpolation. In addition, Growth Energy stated that materials used to construct motor vehicle fuel systems have been certified to industry standards (SAE J1681) that are qualified using fuels containing 15% methanol, which is much more aggressive than ethanol. Since these standards have been used by the automotive industry for the last 15 years, Growth Energy concluded that most motor vehicles in use today should have fuel and evaporative systems compatible with up to 15% ethanol.

c. Public Comment Summary

Commenters responded to Growth Energy's claims by arguing that E15's effect on fuel system materials has not been properly studied. Many commenters noted that Growth Energy may have selectively excluded important findings from the Minnesota Compatibility Study.

[74] "The Effects of E20 on Automotive Fuel Pumps and Sending Units;" Nathan Hanson, Thomas Devens, Colin Rohde, Adam Larson, Gary Mead, Paul Steevens, and Bruce Jones; Minnesota State University, Mankato; February 21, 2008. EPA Docket # EPA-HQ-OAR-2009-0211-0002.28

[75] "An Examination of Fuel Pumps and Sending Units During a 4000 Hour Endurance Test in E20;" Gary Mead, Bruce Jones, Paul Steevens, Nathan Hanson, and Joe Harrenstein, Minnesota Center for Automotive Research at Minnesota State University, Mankota, March 25, 2009. EPA Docket # EPA-HQ-OAR-2009-0211-2721. Also available at http://www.mda.state.mn.us/news/publications/renewable/ethanol/e20endurance.pdf.

[76] Effects assessed in the studies include: pitting, surface texture change, discoloration, or loss of mass for metals; appearance, volume, weight, tensile strength, elongation, and hardness for elastomers; mass loss or gain, volume loss or gain, tensile elongation, impact resistance, and tensile strength for plastics; and corrosion and longevity as measured by flow and pressure tests for pumps and sending units.

Regarding the Metals Study, some comments noted that 14 out of the 19 metal samples that were tested exhibited greater than 50% measurable mass changes when tested with E20 compared to E10, and if those metals had been compared to E0 instead of E10, some mass changes would have exceeded 200%. The Alliance stated that such mass changes in metals "can be a very noteworthy indication of heavily accelerated corrosive effects" since unprotected metals often accelerate in a non-linear fashion.[77] With respect to specific materials, commenters stated that E15 will increase corrosion of terne plate gas tanks which were used in light-duty motor vehicles prior to the mid-1990s.

The Alliance criticized the Elastomers Study for testing raw-materials instead of actual fuel system components (such as hoses, seals, and diaphragms), and argued that the impacts of mid-level gasoline-ethanol blends on raw materials would differ substantially from manufactured parts because manufacturers vary the compounds used in the construction of fuel system parts. The Alliance commented further that most of the materials tested were neither being used nor expected to be used in the future. The Alliance also commented that the study failed to justify how a 500 hour exposure test period provides the ability to predict compatibility of materials. The Alliance added that while studies have shown generally acceptable materials compatibility with ethanol up to 10 vol% ethanol, higher dosages have degraded certain metals, elastomers, plastics, and motor vehicle finishes.[78] The Alliance also commented that many researchers have found that the effects of gasoline-ethanol blends on elastomers may be non-linear with increasing ethanol content and that a blend containing 10-25% ethanol may be more harmful to elastomers

[77] "ALLIANCE OF AUTOMOBILE MANUFACTUERS COMMENTS ON CLEAN AIR ACT WAIVER APPLICATION TO INCREASE THE ALLOWABLE ETHANOL CONTENT OF GASOLINE TO 15 PERCENT, A-22. EPA Docket #EPA-HQ-OAR-2009-0211-2551.1.

[78] SAE J1297, revised July, 2007, Surface Vehicle Information Report, Alternative Fuels.

than E85 or E100.[79] Moreover, the Alliance noted in their comments that over 30 years of research has led to the conclusion that concentrations between 15 and 50% ethanol provide the most challenging environment for elastomers compared to other ethanol levels. Regarding specific elastomers, commenters stated that E15 will damage fuel system components made of nitrile rubber while fluorocarbon elastomers have shown the best resistance to swell, tensile strength, and elongation for ethanol gasoline blends at 10 vol%.[80, 81, 82]

Some commenters also expressed concerns with a particular material, polybutlyene terephthalate (PBT), tested in the Plastics Study. The Alliance noted that PBT experienced a slight elevation in tensile elongation as the percentage of ethanol was increased, and that the study was performed at temperatures lower than would be experienced under real-world driving conditions. Since materials like PBT undergo a chemical transformation when exposed to ethanol, the Alliance argued that the elongation effect on PBT would be greater at the elevated temperatures found in real-world driving conditions. The Alliance concluded that E15 will damage fuel system components made of PBT and noted that at least one fuel system supplier used PBT in fuel pump modules between model years 1993 and 2004.

Several comments noted that the sample size for the Fuel Pumps Study was too small to draw conclusions about the effects of E20 and that the duration of the test program included only a short-term, static soak test of 720 hours as opposed to testing periods of at least 2,000 hours

[79] SAE 800786, "Effects of Mixtures of Gasoline With Methanol and With Ethanol on Automotive Elastomers," Ismat A. Abu-Isa, General Motors Research Laboratory. SAE 2007-01-2738.
[80] SAE 800786, "Effects of Mixtures of Gasoline With Methanol and With Ethanol on Automotive Elastomers," Ismat A. Abu-Isa, General Motors Research Laboratory.
[81] SAE 800789, "The Volume Increase of Fuel Handling Rubbers in Gasoline/Alcohol Blends," Nersasian, A., Passenger Car Meeting, June 9-13, 1980.
[82] SAE 912413 "An Overview of the Technical Implications of Methanol and Ethanol as Highway Motor Vehicle Fuels," Frank Black, U.S. Environmental Protection Agency, Research Triangle Park, N.C.

and up to 10,000 hours usually used to validate fuel pump designs and materials. Several commenters referred to the materials compatibility work in the Orbital Study[83,84] which evaluated the effects of E20 on fuel system components for several older model Australian passenger vehicles.[85]

d. EPA Analysis

The Agency is concerned, based on its review of the literature and automotive industry comments, that most pre-Tier 2 motor vehicles, including Tier 0 vehicles (from the 1980s to 1995) and Tier 1 vehicles (from 1996 to 2001), may have been designed for only limited exposure to E10 and consequently may have the potential for increased materials degradation with the use of E15. This potential for materials degradation may make the emissions control and fuel systems more susceptible to corrosion and chemical reactions from E15 when compared to the certification fuels for these motor vehicles which did not contain any ethanol, and therefore may increase motor vehicle emissions. For MY2000 and older motor vehicles especially, E15 use may result in degradation of metallic and non-metallic components in the fuel and evaporative emissions control systems that can lead to highly elevated HC emissions from both vapor and liquid leaks. Potential problems such as fuel pump corrosion or fuel hose swelling will likely be worse with E15 than historically with E10, especially if motor vehicles operate exclusively on E15. Since ethanol historically comprised a much smaller portion of the

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[83] "Market Barriers to the Uptake of Biofuels Study, A Testing Based Assessment to Determine Impacts of a 20% Ethanol Gasoline Fuel Blend on the Australian Passenger Vehicle Fleet, Report to Environment Australia;" Orbital Engine Company; March 2003.

[84] "Market Barriers to the Uptake of Biofuels Study Testing Gasoline Containing 20% Ethanol (E20), Phase 2B Final Report to the Department of the Environment and Heritage;" Orbital Engine Company; May 2004.

[85] Components were selected from three vehicles, the Holden 1990 VN and 1985 VK Commodore and a 1985 Ford XE Falcon to encompass most component types within the Australian passenger car fleet.

fuel supply, in-use experience with E10 was often discontinuous or temporary, while material effects are time and exposure dependent. Thus, issues may surface with E15 that may not have surfaced historically in-use with E10.

Newer motor vehicles, such as Tier 2 and NLEV vehicles (MY2001 and newer), on the other hand, were designed to encounter more regular ethanol exposure compared to earlier model year motor vehicles. IUVP, introduced under CAP2000, requires manufacturers to perform exhaust and evaporative emissions tests on in-use motor vehicles. This emphasis on real-world motor vehicle testing prompted manufacturers to consider different available fuels when developing and testing their emissions systems. Additionally, beginning with Tier 2, the durability demonstration procedures required the demonstration of evaporative emission system durability on E10. As a result, the materials in Tier 2 motor vehicles have been able to mitigate the permeation effects of ethanol in the fuel, as discussed in section IV.A.2. As a result, our engineering analysis would suggest that Tier 2 compliant motor vehicles are more likely to be compatible with E15 than older motor vehicles.

While Growth Energy asserted that 15% methanol was a worst-case fuel for E15 materials compatibility purposes, the Agency is not aware of any analysis or industry standard practice that confirms that motor vehicle materials tested on 15% methanol test fuels will cover gasoline-ethanol blends up to 15% for materials compatibility and evaporative emissions purposes. SAE J1681 provides specifications and formulations for evaluating oxygenates in gasoline, including ethanol, on automotive fuel system components.[86] EPA's evaluation of SAE

[86] SAE J1681, "Surface Vehicle Recommended Practice, for Gasoline, Alcohol and Diesel Fuel Surrogates for Materials Testing," Issued 1992-09, Revised 2000-01.

J1681 does not reveal that 15% methanol would be the surrogate worst case test fuel in evaluating all oxygenates. To the contrary, the fuel formulations for aggressive methanol and aggressive ethanol are different, as described in Appendix E of SAE J1681. EPA believes this difference is to account for contaminants that may be present in these two different products during production and/or transportation of each product. To properly evaluate the potential worse case impacts of a mid-level gasoline-ethanol blend, such as E15, on motor vehicle fuel systems components, the Agency believes it would be prudent to use the aggressive ethanol fuel formulation provided in Appendix E of SAE J1681, to the extent that it reflects E15 according to ethanol content, as well as any contaminant, that may be associated with the production or transportation of an E15 gasoline product. The Agency notes that SAE J1681 includes language describing potential impacts of oxygenates on metals (from by-products derived from oxygenates and especially when water is present), polymers (including elastomers and plastics), and polymer systems (including laminates and multi-layered components).[87]

e. Conclusions

The Agency has reviewed the studies and information submitted by Growth Energy, commenters, and other publicly available information to further assess the potential materials compatibility performance of E15, including the Minnesota Compatibility Studies.[88] The Minnesota studies were on component parts using laboratory bench tests rather than durability studies of whole motor vehicle fuel systems simulating "real world" motor vehicle use. Such tests are typically used to provide a first level screening of potential materials prior to more real-

[87] Ibid.
[88] SAE J1297, revised July, 2007, Surface Vehicle Information Report, Alternative Fuels.

world testing to demonstrate materials compatibility of actual vehicle and engine components. In addition, the study admittedly assessed only a subset of materials used in motor vehicles and nonroad products over the years, and provided no information with which to correlate the materials tested with those in use in either the MY2007 and newer motor vehicles or older motor vehicles and nonroad products. Manufacturers have continually modified engine, fuel system, and emissions control system materials over the years in response to technology needs, in-use fuel quality changes (including E10), and emission standards. In many cases, they have incorporated special coatings and barriers in existing materials to address problems discovered in the field or in emissions testing. Furthermore, as commenters point out, there were differences found in the testing for some of the materials, which would suggest further testing was necessary. Finally, conclusions Growth Energy reached comparing the results of some of the materials on E20 to E10 are not helpful in assessing the impacts of E15 relative to E0. Consequently, while the Minnesota studies are informative, they cannot by themselves be used to draw any definitive conclusions. Rather, the conclusion is that actual vehicle durability testing is warranted.

In the case of MY2007 and newer motor vehicles, the Agency believes that the DOE Catalyst Study has provided the additional information needed. Along with (1) our engineering analysis of the types of changes manufacturers have made in response to the Tier 2 motor vehicle standards and the rapid rise of E10 use across the nation; (2) the limited information available from the Minnesota studies; and (3) the lack of any information from commenters showing definitive problems on Tier 2 compliant motor vehicles, we believe that the durability testing performed by DOE as discussed in section IV.A.1. above is sufficient to provide assurance that

MY2007 and newer motor vehicles will not exhibit any serious materials incompatibility problems with E15. Not only did the DOE Catalyst Study not uncover any emissions deterioration problems with E15 in comparison to E0, it also did not uncover any material differences upon tear-down and inspection of six of the motor vehicle pairs tested out to FUL.[89] Therefore, the Agency does not expect that there will be materials compatibility issues with E15 that would cause MY2007 and newer light-duty motor vehicles to exceed their exhaust or evaporative emission standards over their full useful lives.

5. <u>Driveability and Operability for MY2007 and Newer Light-duty Motor Vehicles</u>

a. Introduction

In past waiver applications before the Agency, driveability and general operability of the motor vehicle have not necessarily been impacted by the fuel or fuel additive and therefore not significant to the decision making process. However, a change in the driveability of a motor vehicle that results in significant deviation from normal operation (i.e., stalling, hesitation, etc.) can conceivably result in unexpected emission increases and should be considered when evaluating a fuel or fuel additive. These increases may not be demonstrated in the emissions certification test cycles but instead be present during in-use operation. A motor vehicle stall and subsequent restart can result in a significant emissions increase because HC and CO emissions rates are typically highest during cold starts. Further, a consumer or operator might tamper with the motor vehicle in an attempt to correct the driveability by modifying the vehicle from its original certified configuration.

[89] Only a difference in intake valve deposits was seen.

b. Growth Energy's Submission

Growth Energy relies on the Minnesota Driveability Study, the RIT Study, the MCAR Study, and the DOE Pilot Study to support their claim that "E-15 will cause no driveability issues" and will not lead to the removal of or the rendering inoperative of emissions control devices or systems based on negative performance impacts. Growth Energy claims that the RIT Study supports the Minnesota Driveability Study's findings by driving 10 motor vehicles with significant mileage (between 30,000 and 120,000 miles) for over 75,000 miles on E20 under "real world conditions." They argue that the RIT Study's drivers did not detect any performance degradation and there were no engine or fuel part failures that required abnormal maintenance.[90] Growth Energy argues that the MCAR Study, which tested 15 in-use cars and light-duty trucks operating on E10 and E30 for a year, showed "no driveability complaints, no reports of cold starting, vapor lock, or hard starting conditions, and no reports of hesitation with the E-30 blend of fuel."[91] Growth Energy contends that the DOE Pilot Study showed that "none of the vehicles tested displayed a malfunction indicator light as a result of the ethanol content, no fuel filter plugging symptoms were observed, no cool start problems were observed in 75 °F and 50 °F laboratory conditions, and no fuel leaks or conspicuous degradation of the fuel systems were observed."[92]

[90] In Growth Energy's comments submitted during the E15 public notice and comment period, Growth Energy submitted an updated summary for the RIT Study. See below for more details.
[91] Application For A Waiver Pursuant to Section 211(f)(4) of The Clean Air Act For E-15 submitted by Growth Energy on behalf of 52 United States Ethanol Manufacturers see EPA-HQ-OAR-2009-0211, 33.
[92] Application For A Waiver Pursuant to Section 211(f)(4) of The Clean Air Act For E-15 submitted by Growth Energy on behalf of 52 United States Ethanol Manufacturers see EPA-HQ-OAR-2009-0211, 34.

In their application, Growth Energy asserts that the Minnesota Driveability Study, the MCAR Study, and the RIT Study demonstrate that higher gasoline-ethanol blends do not result in driveability or performance problems.

c. Public Comment Summary

Several commenters mention specific methodological issues with the driveability studies included in Growth Energy's waiver request. The Alliance pointed out what they believe to be several flaws with the Minnesota Driveability Study. First, they noted low response rates for the drivers rating operability concerns. Second, the trained drivers did not drive motor vehicles back-to-back on E0 and E20, which made direct comparison of driveability on E0 to E20 impossible. Third, the Alliance argues that many of the batch fuel analyses were suspect, casting doubt on the actual fuel properties used in the study. The Alliance and others had similar critiques with the MCAR Study and also noted that neither the Minnesota Driveability Study nor the MCAR Study were peer-reviewed. With regard to the RIT Study, as mentioned previously, many commenters point out that the study summary provided with Growth Energy's public comments does not provide enough detail to conduct a thorough independent analysis, making it difficult to verify Growth Energy's claims. The Alliance argues that more testing needs to be conducted evaluating how ethanol affects T50 and TV/L in the gasoline-ethanol blends containing greater than 10 vol% ethanol.

Growth Energy responded to these driveability issues in their comments by reiterating the arguments made in their E15 waiver application and noting that the updated summary of the RIT Study that they submitted as part of their comments showed no driveability or mechanical problems with approximately 400 motor vehicles driven on E20 for over 1.5 million miles.

Commenters also raised questions regarding the sensitivity of the OBD system to increased gasoline-ethanol blends and some ongoing studies to quantify potential impacts. Honda submitted some limited data regarding potential motor vehicle sensitivity to higher gasoline-ethanol blends. Additionally, at the Mid-Level Ethanol Blends Research Coordination Group meeting on May 5, 2010, a presentation was made to members regarding possible implications of increased levels of ethanol on the vehicle OBD systems[93]. The presentation described the findings of the first phase of CRC project E-90 which is intended to study the impact of ethanol on OBD systems. Phase 1 of the study was designed to investigate differences in the status of vehicle OBD monitors and other emissions control information in E10 versus E0 areas of the country in an attempt to isolate potential ethanol impacts to OBD. Since E15 and E20 are not currently legal fuels for conventional motor vehicles (i.e., non-flex fuel vehicles), the study used the differences between E0 and E10 to project potential impacts of E15 and E20 on the OBD system but did not actually perform any testing on E15 or E20. Similarly, Honda did not perform any actual testing using E15 or E20 but instead used the E0 to E10 information, combined with potential component tolerance stack-up, to assess risk of having the OBD system set a fault and illuminate the malfunction indicator lamp (MIL).

[93] "E15/E20 Tolerance of In-Use Vehicle OBD-II Systems". Presentation available at http://www.crcao.com/.

d. EPA Analysis

The Agency understands the concern for driveability and other operational issues that could potentially occur with an increase in ethanol content. During the initial introduction of ethanol over 30 years ago, problems with hot fuel handling were encountered due to the ethanol boiling in the fuel system, resulting in operational issues like stalls, engine hesitations, misfires and vapor lock preventing hot restarts. Since the introduction of ethanol, motor vehicles have evolved to alleviate these early issues, mainly through fuel system design. These changes included the switch to fuel injection with an associated increase in the system fuel pressure, all of which have worked to reduce the potential for hot fuel issues when operating on gasoline-ethanol blends. In fact, E85 capable FFVs sold today typically operate at similar or the same fuel pressure as their non-FFV counterparts with no reported issues. Due to the stringent emission standards requiring precise fuel control, Tier 2 vehicles have been engineered with the highest fuel pressure systems in vehicle history which make them also highly robust at managing ethanol's low boiling point. The Agency does not believe that properly functioning fuel injected vehicles, particularly Tier 2 vehicles, will encounter any new heat related operational issues with an increase in ethanol content of the fuel to 15 vol%.

Driveability issues could also occur from incompatibility between E15 and manufacturers' approaches at calibrating a motor vehicle for fuels it is expected to encounter in-use. If the error in fuel quantity, caused by the fuel properties of E15 (i.e., oxygen content), is beyond what the system is designed to compensate for, driveability issues (cold start roughness, hesitations) can arise. However, due to the large variability found in fuels in the market today which can result in similar driveability behaviors, from experience with in-use fuels, manufacturers have employed methods to counter or compensate for fuel differences and try to prevent these driveability issues. Because of the stringent Tier 2 emission standards, Tier 2 vehicles required focused attention to cold start fueling to ensure emission compliance while tolerating the different fuel blends that the vehicle could encounter in-use. This resulted in modification of calibration and control strategies by manufacturers to balance the need for precise cold start fuel that meet both emission requirements and operate properly when fuel properties vary in-use. Because manufacturers already calibrate motor vehicles based on their experience with in-use fuels, combined with lack of any reported driveability issues in any of the E15 and E20 test programs during both laboratory and road testing, the Agency believes that properly functioning and maintained motor vehicles will not experience an increase in driveability issues when operating on a properly blended E15 fuel. Collectively, the RIT Study, Minnesota Driveability Study, MCAR Study and a CRC cold start study[94] did not report any fuel related driveability issues demonstrated across different E15 and E20 seasonally blended fuels and verified during winter, summer and shoulder seasons, supporting the Agency's findings.

Motor vehicles produced since approximately 1995 have been equipped with OBD systems that monitor all aspects of the exhaust and evaporative emissions control system. The Agency recognizes that the additional oxygen content in E15 will be identified by the OBD system as a shift in the fueling requirements. In some motor vehicles, a shift in the fuel requirements beyond predetermined thresholds, based on the manufacturer's research, can result in a MIL illumination. However, across the many different test programs with different motor

[94] CRC Report No. 652, "2008 CRC Cold-Start and Warm-upE85 and E15/E20 Driveability Program," October 2008.

vehicles and duty cycles, including lab testing, mileage accumulation and in-use operation, there were no reported incidences of MIL illumination from the use of increased ethanol for both E15 and E20. Based on this, the Agency believes that properly functioning (i.e., within component tolerances) and maintained motor vehicles will not experience an increase in MIL illumination due to the use of E15. However, for a vehicle that has a component issue or failure (i.e. intake vacuum leak, exhaust leak, etc) which indirectly effects the same OBD monitors as ethanol content, it is possible that the increase in ethanol may push the OBD system monitor over the calibrated thresholds and cause a MIL illumination.

e. Conclusion

The Agency has reviewed the studies and information submitted by Growth Energy, commenters, as well as other information from the emissions and durability test programs to assess the potential for driveability and diagnostic issues on Tier 2 motor vehicles (i.e., MY2007 and newer). With the exception of ethanol content, fuel properties were largely allowed to vary across the different studies and test programs (i.e., gasoline blend stocks varied between programs and season). This included ethanol blends as high as E30 in the MCAR Study and the program with the largest amount of vehicles, the RIT study, operating on E20 throughout the year which included summer, winter, spring, and fall operation. In these two studies where the ethanol levels exceeded E15 and the vehicles were operated in a relatively uncontrolled manner (i.e., not driven on a specific duty-cycle), there were no reported driveability issues or OBD related problems on the vehicles.

The DOE test programs, both the DOE Pilot Study and the DOE Catalyst Study, did not report any occurrence of driveability or diagnostics issues throughout the testing. For the durability program, mileage accumulation on the Tier 2 vehicles occurred at three locations including one location at altitude (Denver Colorado). For the mileage accumulation, fuels where made by splash blending locally available commercial fuels. Vehicle mileage accumulation was performed both on mileage accumulation dynamometers and on a track with actual drivers. There were no reported driveability issues or OBD related problems during the mileage accumulation period on the Tier 2 vehicles at the various testing locations.

The Agency's review of the data and information from the different test programs finds no specific reports of driveability, operability or OBD issues across many different vehicles and duty cycles including lab testing and in-use operation. Thus, while the potential exists for some vehicles more sensitive to ethanol to experience driveability or operability issues, the frequency is likely not more than what is currently experienced in-use today. Therefore, the Agency does not anticipate that there will be driveability, operability or OBD issues with E15 on properly operating and maintained MY2007 and newer light-duty motor vehicles.

6. Overall Immediate and Long-term Emissions Conclusions

As described in the preceding sections, EPA evaluated Growth Energy's submission based on five factors: long-term exhaust emissions impact over time, immediate exhaust emissions impact; immediate and long-term evaporative system impacts; the impact of materials compatibility on emissions; and the impact of drivability and operability on emissions. Based on results from the DOE Catalyst Study in particular coupled with our engineering judgment, EPA believes there is strong evidence that MY2007 and newer light-duty motor vehicles will not exceed their emission standards over their useful life when operated on E15. Therefore, EPA is granting the waiver for MY2007 and newer light-duty motor vehicles.

B. MY 2001-2006 Light-duty Motor Vehicles

EPA is deferring its decision on MY2001–2006 light-duty motor vehicles. DOE is in the process of conducting additional catalyst durability testing that will provide data regarding MY2001-2006 motor vehicles. The DOE testing is scheduled to be completed by November 2010. The data will be made available to the public. EPA will then consider these data and other data and information available to make a further determination on the use of E15 in those MY motor vehicles.

C. MY2000 and Older Light-duty Motor Vehicles

Due to differences in vehicle standards and technology over time and in light of the data and information available, the Agency has chosen to split consideration of the E15 waiver request into model year groupings. This section concerns MY2000 and older light-duty motor vehicles.

Table IV.C-1: Tier 0 and Tier 1 Emission Standards Phase-in by Model Year

	Tier 0	Tier 1 Phase-in Percentage

		MY1994	MY1995	MY1996
Passenger car	MY1981 and newer*	40	80	100
Light duty truck <6000 GVW	MY1988 and newer	40	80	100
Light duty truck >6000 GVW	MY1990 and newer		50	100

* Final diesel particulate standard required came in 1987

MY2000 and older light-duty motor vehicles have much less sophisticated emissions control systems compared to today's vehicles and, as described below, may experience conditions that lead to immediate emission increases and may exceed their emission standards if operated on E15. Vehicles produced prior to the mid-1980s were equipped primarily with carbureted engines. The A/F ratio of the carburetor is preset at the factory based on the expected operating conditions of the engine such as ambient temperature, atmospheric pressure, speed, and load. As a result, carburetors have "open loop" fuel control which means that the air and fuel are provided at a specified, predetermined ratio that is not automatically adjusted during vehicle operation. As fuel composition can vary, an engine with a carburetor and open loop fuel control would never know if it achieved the desired A/F ratio or not. Since the vehicles at this time operated "open loop" all of the time with no ability to react to changes in the A/F ratio, the addition of ethanol to the fuel tended to make the A/F ratio leaner, typically resulting in an immediate emission impact of reducing HC and CO emissions, but increasing NOx emissions. However, some of these older open loop systems already operate at the lean edge of combustion on current commercial fuels so an increase in ethanol may cause them to begin to misfire resulting in HC and CO increases.

As a result of the Clean Air Act of 1970, EPA established standards and measurement procedures for exhaust, evaporative, and refueling emissions of criteria pollutants. From 1975 into the 1980s, vehicles became equipped with catalytic converters, first with catalysts capable of oxidizing HC and CO, and then, in response to EPA's 'Tier 0' standards, with three-way catalysts that also reduced NOx. With the 'Tier 0' standards, closed loop fuel control was required to maintain proper fuel air ratio control necessary to achieve high conversion efficiency in the three way catalyst. In most vehicles this was accomplished through the use of feedback carburetors. Vehicles produced from the late 1980s and even more so into the 1990s, as a result of more stringent California and Federal standards, evolved to incorporate more sophisticated and durable emission control systems. These systems generally included an onboard computer, oxygen sensor, and early electronic fuel injection with more precise closed loop fuel compensation and therefore A/F ratio control during more of the engine's operating range. However, even with the use of closed loop systems through the late 1990s, the emission control system and controls remained fairly simple with a limited range of authority and were primarily designed to adjust for component variability (i.e., fuel pressure, injectors, etc.) and not for changes in the fuel composition. During this period, ethanol was only available in very limited areas of the US so the manufacturers' designs of the emission controls and the durability of emission control hardware generally did not account for the increased oxygen content of ethanol. As a result, this generation of vehicles certified to Tier 0 and early Tier 1 emission standards experienced immediate emission impacts of ethanol and likely also deteriorated at different rates when exposed to ethanol. These designs continued to evolve during the early period of the Tier 1 emission standards as manufacturers and component suppliers gained experience with vehicles in-use. However, the largest improvements to emission controls and hardware durability came after 2000 with the introduction of several new emission standards and durability requirements forcing manufacturers to better account for the implications of in-use fuels on the evaporative and exhaust emission control systems.

The NLEV program for exhaust emissions began federally with MY2001 (MY1999 in the northeast trading region within the NLEV program) for all cars and light trucks up to 6000 lbs. GVW. This program essentially adopted the existing California LEV certified vehicles as a national vehicle program. These NLEV vehicles met more stringent emission standards for all criteria emissions requiring substantial changes to emission control hardware and strategies compared with Tier 1 vehicles. The LEV and NLEV programs largely were the start of a migration to emission control hardware and strategies resembling future Tier 2 program approaches (e.g. independent catalyst per bank on V engines). Many of the improvements (i.e. catalyst designs, washcoat formulation) may have been leveraged by the remaining new Tier 1 vehicles, mainly the over 6000 lbs. GVW trucks not required to comply with the NLEV standards, but to what degree is unknown.

The CAP2000 program was implemented for MY2001 and later vehicles. The CAP2000 program was designed to place more emphasis on in-use performance of vehicle emission controls with vehicles operating nationwide on the different available fuels. The IUVP introduced under CAP2000 requires manufactures to perform exhaust and evaporative emissions tests on customer vehicles. These tests must be performed at low and high mileage intervals and include at least one vehicle per test group[95] at 75% of full useful life. This emphasis on real world vehicle testing prompted manufacturers to consider different available fuels when developing and testing their emissions systems.

Under the CAP2000 program, manufacturers are allowed to design durability processes that predict in-use deterioration. Prior to CAP2000, manufacturers would run traditional durability programs to calculate emissions deterioration which generally required that vehicles accumulated mileage out to their full useful life under highly controlled conditions and fuels. Under the new program with increased emphasis on in-use emission levels, manufacturers must confidently ensure that their in-use emission deterioration is as predicted.

The Enhanced Evaporative Emissions requirements were fully phased in for light-duty vehicles by 1999. These new requirements included both new standards and new test procedures: the 2-day and 3-day diurnal tests with new canister loading procedures. In addition, the durability demonstration procedures that took effect with the Tier 2 program beginning in 2004 required the use of at least the maximum ethanol concentration permitted by federal law that is commercially available for the entire service accumulation period.

Along with the Enhanced Evaporative Emissions requirements, OBD requirements for evaporative leak detection monitors were introduced. This required vehicles to detect a leak equivalent to .040 inch in the fuel or evaporative emissions system. Beginning in 2001, EPA

[95] EPA certifies light-duty motor vehicles on a test group basis. A test group is a group of vehicles having similar design and emission characteristics.

allowed manufactures to comply with California OBD regulations, which required vehicles to detect a leak equivalent to a .020 inch. While not required federally, many manufacturers developed one leak detection system for sale in all 50 states, which complied with the more stringent California requirement.

By MY2004, the SFTP was fully phased in. Additional test procedures were developed to better represent the driving habits and conditions experienced in actual customer driving. These procedures expanded the vehicle testing to include the US06 test, a high speed and high acceleration cycle, the SCO3 test, an air conditioning test cycle run in an environmental test chamber at 95 °F, and a 20 °F cold test run on the FTP cycle. These additional test cycles coupled with the in-use testing required under CAP2000 have pushed manufactures to develop robust emissions control systems capable of withstanding the higher temperatures experienced on these more severe cycles.

The tightening evaporative emission standards, the durability requirement to include prolonged exposure to ethanol in the fuel, the CAP2000 requirement to test high mileage in-use vehicles, and the OBD leak detection requirement have all combined to compel manufacturers to develop more durable evaporative emission systems and focus on testing with fuels that would be encountered in customer vehicles, including fuels containing ethanol. Thus, MY2000 and older vehicles have not benefitted from many of the design changes that MY2007 and newer light-duty motor vehicles have. Therefore, we do not have the same confidence with MY2000 and older light-duty motor vehicles as we do with MY2007 and newer light-duty motor vehicles with respect to operation on E15.

1. Growth Energy's Submission

Growth Energy's waiver application covered all model years of motor vehicles – they made no specific claims specific to MY2000 and older motor vehicles. A summary of Growth Energy's submission with respect to the potential impacts of E15 on (1) exhaust emissions, both long-term durability and immediate impacts, (2) evaporative emissions, both long-term durability and immediate impacts, (3) materials compatibility, and (4) driveability and operability for MY2007 and newer light-duty motor vehicles is discussed in the respective subsections within Section IV.A. Since Growth Energy's waiver application was for all model years of motor vehicles, the summary of their submission contained in Section IV.A is also applicable here for MY2000 and older light-duty motor vehicles.

2. Public Comment Summary

Similar to the broad applicability of Growth Energy's submission, the public comments received tended to cover all model years of light-duty motor vehicles, and the summary of comments received contained in section IV.A. is also applicable here. However, the Alliance specifically commented that historically, it has taken about 20 years for an entire vehicle fleet to turn over, but with current depressed sales due to poor economic conditions, the turn-over rate could be slower in the near future and that a well-executed study should have a test fleet that is proportionally similar to the model years that comprise the national fleet. The Alliance argued that the bulk of the emissions data cited in Growth Energy's waiver request focus on newer (i.e., Tier 2) vehicles and do not adequately represent the national vehicle fleet and that these older vehicles may be more sensitive to the effects of higher ethanol blends and constitute a greater portion of the number of vehicles currently in use. Specifically the Alliance commented that the DOE Pilot Study presents data from R. L. Polk describing the U.S. fleet but did not select the vehicles to statistically represent that fleet. The study included no Tier 0 vehicles, for example, and the selected test vehicles did not proportionally represent the vehicles in the Polk table. The test program generally ignored pre-1999 motor vehicles, even though they will continue to be a large portion of the legacy fleet for many years. These older motor vehicles are most likely to have operational and emissions issues with E15 and E20.

The Alliance also commented that many years of automaker experience with developing and producing vehicles capable of using E22, E85 and E100 fuels have shown that engines need to be hardened for resistance to ethanol. Use of ethanol blends in unhardened engines can result in bore, ring, piston and valve seat wear. Deterioration of these components can lead to compression and power loss, misfire and catalyst damage

Finally, EPA recently received a report by Ricardo[96] commissioned by the Renewable Fuels Association specifically discussing the potential impacts of E15 on MY2000 and older light-duty motor vehicles. This report's conclusions stated that:

> "While performing an engineering assessment on a fleet of such magnitude as the current US motor vehicle fleet, it was necessary to make certain assumptions and approximations

[96] Ricardo Inc., *Technical Assessment of the Feasibility of introducing E15 Blended Fuel in U.S. Vehicle Fleet, 1994 to 2000 Model Years*, 10 September, 2010. EPA Docket # EPA-HQ-OAR-2009-0211-14007.1.

to allow an overall assessment to be made. Due to this unavoidable circumstance, there are certain exceptions to the overall findings of this study which may occur in the field due to unpredictable conditions outside the scope of normal operation. Without investigating each and every vehicle in the fleet individually for its reaction to an E15 fuel blend, there cannot be 100% certainty that some vehicles will not observe adverse effects from the use of E15. However, using statistical analysis, the fleet was reduced to a more manageable and representative collection of platforms and manufacturers. The vehicles arising from this methodology were evaluated and served as representative vehicles for the time period.

The effect of E15 on various vehicle systems were assessed for vehicles in the 1994 to 2000 MY time period. Overall, moving from the use of E10 to E15 in the current U.S. light vehicle fleet is seen as a low risk from an engineering analysis perspective. While certain risks do remain, they are manageable and exist in vehicles that are outside the normal bounds of "standard" vehicles in the 1994 to 2000 MY timeframe."

3. <u>EPA Analysis and Conclusion</u>

a. Scope of MY2000 and Older Data to Support a Waiver Decision

As highlighted by the Alliance in their comments, Growth Energy did not provide information to broadly assess the emission performance of E15 in all motor vehicles in the in-use fleet, and this is particularly true of MY2000 and older motor vehicles. Furthermore, there are important differences in design between the MY2000 and older and MY2007 and newer (Tier 2) vehicles that makes it impossible to simply rely on data collected on more recent model year vehicles.

Growth Energy did make reference to the RIT and MCAR studies which included some vehicles from MY2000 and older. However, as discussed in section IV.A, these studies have the following limitations: The vehicles tested in these studies do not fully represent the MY2000 and older fleet. The RIT study only performed emissions testing on 2 vehicles from MY2000 and older and the mileage accumulated on E20 for each vehicle was far less than the 120,000 mile FUL. Since the MCAR study did not use federal test procedures it would be difficult to determine compliance to federal emissions standards. Therefore, it is not possible to draw adequate conclusions concerning the potential impacts of E15 on the emission performance of MY2000 and older vehicles from these studies.

The Agency is not aware of any other information that would allow us to fully assess the potential impacts of E15 on the emission performance of MY2000 and older vehicles. The recently released Ricardo study, despite its focus on MY1994-2000 motor vehicles, does little to change this understanding. EPA believes that the Ricardo study offers little additional data and information with which to assess the emissions effect of E15 on MY2000 and older motor vehicles. First and most importantly, Ricardo did not perform any emissions or durability testing of E15 on MY2000 and older light-duty motor vehicles. Rather, they conducted a literature search of existing data and information already cited by Growth Energy, commenters, or otherwise available to the Agency, and simply focused their discussion on MY1994-2000 vehicles instead of all MY2000 and earlier vehicles. Second, the only new data and information provided in the Ricardo study was their visible inspection of fuel system components from 11 MY1994-2000 motor vehicles that were evaluated for any visible signs of material compatibility or durability issues. The fuel systems were collected from a reclamation service in Southeast Michigan (Southeast Michigan has had varying levels of E10 market penetration over the years). However, as the authors acknowledge, since no vehicle history records were available to indicate to what extent the fuel systems may have been exposed to E10, if at all, during their lifetimes, it is impossible to draw any definitive conclusions regarding the effects of ethanol on these components. Finally, the authors did not draw any conclusions as to the potential impacts of E15 relative to E0. The authors only concluded that "The analysis concluded that the adoption and use of E15 would not adversely affect fuel system components in properly engineered vehicles, nor would it cause then to perform in a sub-optimal manner, when compared to the use of E10."

In addition to the paucity of data on MY2000 and older motor vehicles, as discussed below, there are reasons for concern with the use of E15 in these motor vehicles, particularly with respect to long-term exhaust and evaporative emissions durability. This makes it difficult to rely on an engineering assessment and makes the need for actual emissions data critical.

b. Exhaust Emissions - Long-term Durability

i. *General Tailpipe Emissions Durability Concerns*

Ethanol enleans the A/F ratio, which leads to increased exhaust gas temperatures and therefore potentially incremental deterioration of emission control hardware and performance. Over time, the enleanment caused by ethanol has the potential to cause catalyst failure. This effect of E15 and the use of closed loop fuel trim to mitigate the effect are discussed in more detail in section IV.A.1.c.i above.

The A/F ratio of the carburetor is preset at the factory based on the expected operating conditions of the engine such as ambient temperature, atmospheric pressure, speed, and load. As a result, carburetors have "open loop" fuel control, which means that the air and fuel are provided at a specified, predetermined ratio that is not automatically adjusted during vehicle operation. As fuel composition can vary, an engine with a carburetor and open loop fuel control would never know if it achieved the desired A/F ratio or not. Since the vehicles at this time operated "open loop" all of the time with no ability to react to changes in the A/F ratio, the addition of ethanol to the fuel tended to make the A/F ratio leaner. This leaner operation could increase catalyst temperature and therefore increase the emissions deterioration rate.

For MY2000 and older light-duty motor vehicles, which are capable of operating with closed loop fuel control, the fuel trim range is generally more limited than the range for newer vehicles, and these vehicles may use their full range of fuel trim adjustment to account for normal component deterioration. Injectors, sensors and changes to fuel pressure may shift with time and aging to use all of the fuel trim's range of adjustment. The additional oxygenate in E15 may actually shift the A/F ratio more than the earlier introduction of E10 if the engine's A/F feedback cannot compensate because it has reached its adjustment limit. In short, MY2000 and older motor vehicles and earlier are at risk of having insufficient thermal margins to accommodate ethanol blends up to E15 due to the limits of their fuel trim authority.

There is very little test data on the use of E15 in older vehicles but the concern is more than just theoretical. Three studies – the CRC Screening Study, DOE Pilot Study, and the Orbital Study – discussed in section IV.A. highlight in particular the concern with MY2000 and older motor vehicles. The CRC Screening Study (E-87-1) was a test program developed to look at the effects of mid-level ethanol blends on U.S. vehicles. This screening study was the first phase of a two-phase study evaluating the effects of mid-level ethanol blends on emission control systems. The purpose of this first phase of the study was to identify vehicles which used learned fuel trims to correct open loop air-fuel rations. Under the test program a fleet of 25 test vehicles was identified and acquired with six of those vehicles being MY2000 and older. The study collected vehicle speed, oxygen sensor air-fuel-ratio, and catalyst temperature data for four fuels (E0, E10, E15, and E20). The results of the three ethanol blended fuels compared to E0 showed that four of the six MY2000 and older vehicles tested failed to apply long-term fuel trim to open loop operation in order to compensate for increasing ethanol levels. And that these same four vehicles exhibited increased catalyst temperatures when operated on E20 as compared to E0. While the subsequent DOE Catalyst Study concluded that this learned fuel trim was not important for MY2007 and newer motor vehicles because they are durable (and therefore can handle E15) as discussed in section IV.A, there was no such follow on program for MY2000 and older motor vehicles so the durability of these vehicles on E15 is unknown.

Another study suggests that many MY2000 and older motor vehicles may also have emission exceedances if operated on E15. In 2003, the Orbital Engine Company issued a report on the findings of vehicle testing it completed to assess the impact of E20 on the Australian passenger vehicle fleet. While the Australian vehicles in this study were not representative of U.S. vehicles of the same model years, they are similar to MY2000 and older U.S. motor vehicles with respect to technology and emission standards. The testing program covered vehicle performance and operability testing, vehicle durability testing, and component material compatibility testing, on nine different vehicle makes or models, five vehicles from MY2001 and four vehicles from MY1985 to MY1993. Testing results showed increases in exhaust gas temperature in five of the nine vehicles tested with three showing increases in catalyst temperature. Enleanment was found to occur in six of the nine vehicles tested, with three having closed loop control – the old vehicles without closed loop control all displayed enleanment. In general, the increase in exhaust gas temperature was found to follow those vehicles with enleanment. Furthermore, one vehicle in the study experienced catalyst degradation sufficient to make the tested vehicle no longer meet its applicable Australian emission standards.

Hence, based on this very limited test data and our engineering judgment, we can conclude that MY2000 and older motor vehicles have the potential to experience conditions when operated on E15 which may ultimately lead to an increase in exhaust emissions. Specifically, enleanment followed by higher exhaust temperatures could cause accelerated catalyst deterioration. Furthermore, there are potential concerns other than just catalyst durability for these older vehicles, as highlighted by the Alliance in their comments. Absent actual emissions durability testing, it is not possible to know the validity of these emissions concerns with E15 in MY2000 and older motor vehicles. Unlike for MY2007 and newer motor vehicles we are not aware of any existing test program which can address the lack of data concerning MY2000 and older motor vehicles.

ii. *Immediate Exhaust Emission Impacts*

Growth Energy claims that the ACE Study, the RIT Study, the MCAR Study, and the DOE Pilot Study show that E15 results in decreased emissions of NOx, NMHC, and CO on average, and no increase in NMOG emissions when compared to E0. Growth Energy argues that these studies demonstrate E15 will not cause or contribute to the failure of vehicles to meet their emissions standards. While much of the data cited by Growth Energy was on E20, they argued that because the studies they submitted with their application show favorable emissions performance on blends that contained higher than 15% ethanol (i.e. E20), those results should be applicable to E15 by interpolation.

As discussed in IV.A.1, the ACE study, RIT Study, and MCAR Studies offer little value in assessing the impact of E15 on immediate exhaust emissions. Since the DOE Pilot Study focused only on motor vehicles newer than MY2000, Growth Energy provided very little information of value in assessing the immediate exhaust emission impacts of E15. Furthermore, very little data has been collected on E15 on MY2000 and older vehicles. However, also as discussed in section IV.A.1.b., the Agency believes that there is sufficient data on older vehicles to quantify the immediate emission impacts of E10 on older vehicles and furthermore sufficient data from testing E15 primarily on newer vehicles to have a reasonable projection of what the immediate emission impacts of E15 are likely to be on MY2000 and older vehicles. Specifically, as discussed in section IV.A.1.b., EPA would anticipate, that the immediate emission impact of E15 will be similar for both older vehicles and MY2007 and newer vehicles - to decrease NMOG (as well as NMHC and total HC) and CO emissions and to increase NOx emissions, with increases in NOx in the range of 5-10%. The importance of this NOx increase is a function of what the durability impacts might be, since they must be taken into consideration together when evaluating potential impacts on compliance with emissions standards.

c. Evaporative Emissions

Much of the discussion in section IV.A.2 applies to MY2000 and older motor vehicles. However it is important to note that this group of vehicles has several key differences.

First, the majority of these vehicles were designed and built prior to the enhanced evaporative emissions requirements. These vehicles were tested using the 1-hour diurnal plus hot soak procedure only. The CRC E-77 test programs showed that permeation emissions are considerably higher on pre-Tier 2 motor vehicles than on Tier 2 motor vehicles. Therefore it is expected that permeation emissions with E15 on MY2000 and older motor vehicles will be much higher than that discussed in section IV.A.3. for MY2007 and newer motor vehicles. However, given that the evaporative emission standards that applied to MY1998 and older motor vehicles (pre-enhanced evaporative emission control standards), used only a 1-hour diurnal test, the increased permeation emissions would not show up appreciably in the certification testing and could not cause motor vehicles to exceed the emission standard.

Second, the MY2000 and older motor vehicles were not required to demonstrate evaporative emissions durability with fuels containing ethanol. Furthermore, E10 had a limited market share during the time when many of these motor vehicles were designed and built. This raises the concern that the fuel and evaporative emissions system components may not have been designed for constant exposure to E10, and especially not E15. These older motor vehicles could experience significant material compatibility issues (as discussed below) that could lead to elevated evaporative emissions over time or both fuel and vapor leaks. Thus, while the immediate evaporative emission impacts of E15 may not be a waiver concern, evaporative emission durability would be a primary concern for MY2000 and older motor vehicles. Finally, these motor vehicles were not subject to OBD leak detection, so if problems did occur there would be no OBD warning for the vehicle owner.

d. Materials Compatibility

The Agency has reviewed the studies that have shown generally acceptable materials compatibility in newer motor vehicles (i.e. Tier 2 motor vehicles) with ethanol up to 10% by volume, but degradation of certain metals, elastomers, plastics, and vehicle finishes with higher dosages.[97] However, most of these studies, including the Minnesota Compatibility Study, were on component parts using laboratory bench tests rather than durability studies of whole vehicle fuel systems simulating "real world" vehicle use. In addition, there is no way to correlate the results of the study with MY2000 and older motor vehicles. Many different materials were used over the years and we do not have data that shows which manufacturers used which specific

[97] SAE J1297, revised July, 2007, Surface Vehicle Information Report, Alternative Fuels.

materials at various points in time. We can conclude, however, that some portion of the fleet may experience changes that could result in accelerated component failures beyond what would be expected on E0 or E10. We are especially concerned that older motor vehicles may not have been designed to accommodate ethanol blends.

The Agency believes, based on its review of the literature and automotive industry comments, that a number of pre-Tier 2 motor vehicles, including Tier 0 motor vehicles (from the 1980s to 1995) and Tier 1 motor vehicles (from 1996 to 2001), may have been designed for only limited exposure to E10 and consequently may have the potential for increased material degradation with the use of E15 even though they are beyond their useful life requirements. This potential for material degradation may make the emissions control and fuel systems more susceptible to corrosion and chemical reactions from E15 when compared to the certification fuels for these motor vehicles which did not contain any ethanol, and therefore may increase vehicle emissions. For MY2000 and older motor vehicles, especially, E15 use may result in degradation of metallic and non-metallic components in the fuel and evaporative emissions control systems that can lead to highly elevated hydrocarbon emissions from both vapor and liquid leaks. Potential problems such as fuel pump corrosion or fuel hose swelling will likely be worse with E15 than historically with E10, especially if motor vehicles operate exclusively on it. Since ethanol historically comprised a much smaller portion of the fuel supply, in-use experience with E10 was often discontinuous or temporary, while material effects are time and exposure dependent. Thus, issues may surface with E15 that have not surfaced historically in-use.

The authors of the Ricardo study acknowledge that "Many materials have been used in the fuel systems of light duty motor vehicles, small engines, and off-road equipment. Limiting the scope to light duty motor vehicles, including passenger cars and light trucks, from the target range of model years (1994 to 2000) it is impractical to complete a comprehensive survey of the materials that might be exposed to liquid fuels." This highlights the concern that older motor vehicles could experience significant material compatibility issues.

e. Driveability and Operability for MY2000 and Older Light-duty Motor Vehicles

Very little test data was submitted regarding driveability and general operability of MY2000 and older light-duty motor vehicles operating on E15. However as discussed in the MY2007 and newer light-duty motor vehicle analysis, past issues with driveability and operability of older technology fuel controls have been observed with fuels containing ethanol. Hence, absent data to prove otherwise, there is uncertainty regarding the ability of MY2000 and older motor vehicles to handle E15. We have concerns that these motor vehicles could experience driveability and operability issues that may also lead to an emissions increase.

f. Conclusions

It is the burden of the applicant to demonstrate that any new fuel or fuel additive that requires a waiver under CAA section 211(f)(4) of the substantially similar prohibition in CAA section 211(f)(1) will not cause or contribute to the failure of motor vehicles to meet their emissions standards over the vehicles' full useful life. Growth Energy has not made this demonstration for MY2000 and older light-duty motor vehicles as Growth Energy has not provided sufficient data and information to broadly assess the performance of these motor vehicles while using E15. Additionally, based on our own engineering judgment after review of all available data and information for MY2000 and older light-duty motor vehicles, we find that there are concerns about potential emissions increases with the use of E15 in these vehicles, particularly regarding long-term exhaust and evaporative emissions (durability) impacts and materials compatibility. Therefore, the Agency has concluded that it cannot grant a waiver for the use of E15 in MY2000 and older light-duty motor vehicles based on existing data.

V. Nonroad Engines and Equipment (Nonroad Products)

A. Introduction

Past waiver decisions were made solely on the basis of the emission impacts of the fuel or fuel additive on motor vehicles. However, with the passage of the Energy Independence and Security Act of 2007, CAA section 211(f)(4) was expanded to require that the emissions impacts on nonroad engines and nonroad vehicles (collectively referred to as nonroad products in this section) also be taken into consideration when reviewing a waiver application. Nonroad products for the following discussion is defined as those nonroad products that contain spark-ignition engines and are used to power such nonroad vehicles and equipment as boats, snowmobiles, generators, lawnmowers, forklifts, ATVs, and many other similar products. These nonroad products are typically used only seasonally and occasionally during the season which is very different from the daily use of automobiles. Due to the seasonal and occasional use, consumers can hold onto and use their nonroad products over decades with some being 30 or 40 years old. Nonroad engines are typically more basic in their engine design and control than engines and emissions control systems used in light-duty motor vehicles, and commonly have carbureted fuel systems (open loop) and air cooling (extra fuel is used in combustion to help control combustion and exhaust temperatures).

EPA received authority to regulate emissions from nonroad products with the Clean Air Act Amendments of 1990. Through a series of subsequent rulemakings, EPA has promulgated exhaust emission standards for the categories of new nonroad engines that use motor vehicle gasoline: (1) small spark-ignition engines, (2) large spark-ignition engines, (3) marine spark ignition engines, and (4) recreational engines. Evaporative emission standards (tank permeation, hose permeation, diurnal and running loss) have been promulgated on a portion of the nonroad products in these categories. Thus, like for motor vehicles, EPA's emissions impact analysis for nonroad products concentrates on the following four major areas: (1) exhaust emissions, both immediate and longer-term durability, (2) evaporative emissions, both immediate and long-term; (3) materials compatibility, and (4) driveability.

The following table summarizes the various nonroad products and their applicable emissions standards. The current standards are to be met after a period of engine aging which is done on either a dynamometer or chassis per regulation requirements per nonroad sector.

Table V.A -1 Summary of Nonroad Sectors and Applicable Emission Standards

NONROAD SECTOR (Spark Ignition Only)	Current/Future Emission Standards Exhaust Emission Standards (g/kWhr or other noted)	 Evaporative Emission Standards
SMALL ENGINES <19KW – first regulated 1997		
Class I Lawnmowers, pumps	2012: HC+NOx: 10, CO: 519 Life: 125/250/500 hours	First evaporative standards in 2010-2016 -fuel tank permeation -fuel line permeation -running loss -diurnal
Class II Garden tractors, utility vehicles	2011: HC+NOx: 8, CO: 519 Life: 250/500/1000 hours	
Class III Trimmers	2007: HC+NOx: 50, CO: 805 Life: 50/125/300 hours	
Class IV Trimmers, blowers, chainsaws		
Class V Chainsaws	2007: HC+NOx: 72, CO: 603 Life: 50/125/300 hours	
LARGE ENGINES – first regulated 2004		
>19kW and not included in another category -typically retrofitted automotive engines, -Commercial applications – mowing, power generating, farm, construction, industrial	2007: General cycle: HC+NOx: 2.7, CO: 4.4 Life: 7 yrs/5000 hours whichever first	-Fuel line permeation -diurnal emissions -running loss emissions
	2007: Severe Duty: HC+NOx: 2.7, CO: 130 Life: 7yrs/1500 hours whichever first	
MARINE ENGINES – first regulated 1997 (OB and PWC), 2010 SD/I		
Outboard (OB)	2010 =/< 4.3kW: HC+NOx: 30 >4.3kW: HC+NOx: calculation based on engine's max power	First regulations in 2009: Fuel tank permeation Fuel line permeation Diurnal fuel tank vapor

	CO: </=40kW= calc based on engine's max power, >40kW=300 g/kWhr	Refueling emissions provisions
Personal Watercraft (PWC)	LIFE:350 hours/10 yrs (OB) LIFE: 350 hours/5 yrs (PWC)	
Sterndrive Inboard Engines (SD/I) -Typically marinized basic automotive engines	2010: HC+NOx: 5 g/kWhr CO: 75 g/kWhr LIFE: 480 hours/10 yrs High performance engine standards	
RECREATIONAL ENGINES – first regulated 2006		
Nonroad Motorcycles[98]	2007: HC+NOx: 2.0 g/km CO: 25 g/km LIFE: 5 yrs/ 5,000/ 10,000 km depending on size	First regulations 2008: fuel tank and fuel line permeation
ATV	2007: HC+NOx: 1.5 g/kW CO: 35 g/kW LIFE: =/>100cc: 5 yrs/ 1,000 hrs/ 10,000km <100cc: 5 yrs/500 hrs/5,000km	
Snowmobiles	2010-2011: HC: 75 CO: 275 LIFE: 400 hours/ 5 yrs/ 8,000 km 2012 standards exist with max allowable family emission limits	

Typical emission control strategies for nonroad products include enleanment and engine redesign with some limited number of nonroad products adding catalysts. A limited number of nonroad products have also incorporated electronic fuel injection; however the vast majority of all nonroad products still use open loop fuel systems (either carbureted or fuel injected) and hence do not adjust automatically for oxygenated fuel. The result of all this is that there is a

98 On-highway motorcycles have separate emissions standards and minimum useful life requirements, which may be found in 40 CFR Part 86 Subpart E.

broad range of nonroad engine and equipment designs across the nonroad sector, making it difficult to apply data or conclusions from one nonroad product broadly. For example, the following list shows the various trends in design changes in nonroad engines due to emission regulations.

- Small spark-ignition Class I and Class II (nonhandheld) engines are typically open loop carbureted 4-stroke, side valve or overhead valve design, air and fuel cooled engines. Engine manufacturers have incorporated changes to the engine designs (improving combustion chamber design, adding valve guides, improving cooling, etc.), incorporated catalysts on some models and enleaned engine operating A/F ratios from past richer operation approaches.
- Small spark-ignition Class III-Class V (handheld) engines are typically open loop carbureted 2-stroke,air and fuel cooled engines. Engine manufacturers have incorporated changes to the 2 stroke engine designs including reduced scavenging, lean out the A/F ratio, from past richer operation approaches, and catalysts (on some models). Some manufacturers have switched to 4-stroke design or mixed (2- and 4-stroke) design where the application allows.
- Large Spark Ignition Engines are typically retrofitted automobile engines and a number of them do run on motor vehicle gasoline. These engines are water cooled and run feedback electronic controls much like their automotive equivalent.
- Marine outboard and personal watercraft engines were typically open loop carbureted 2 stroke engines. Today these engines are typically open loop 4-stroke engines or direct injected 2-stroke engines. Engines are water cooled.

- Marine sterndrive/inboard engines are typically open loop 4-stroke carbureted or electronic fuel injection and emission regulations in 2010 are expected to result in catalysts on sterndrive/inboard engines and possibly closed loop electronic fuel injection. Engines are water cooled.
- Off-highway motorcycles and ATVs have typically been open loop carbureted 2-stroke and 4-stroke engines but are becoming more 4-stroke design with some fuel injection. These engines are typically air and fuel cooled.
- Snowmobile engines have typically been open loop carbureted 2-stroke engines but have recently started to migrate towards fuel injection and even some 4-stroke engines.

B. Growth Energy Submission

Growth Energy provided only limited information in support of their waiver request application regarding the potential emission impacts of E15 on nonroad products. For addressing the potential long-term exhaust emission (durability) impacts, Growth Energy refers to a single study of ethanol blend use in nonroad engines: the DOE Pilot Study. Growth Energy states in its application that the DOE Pilot Study compared regulated emission levels from a comprehensive and nationally representative fleet of 28 small nonroad engines (SNREs), and that the DOE Pilot Study showed that regulated emissions were no worse for E15 and E20 when compared with E0. Growth Energy argues that the DOE Pilot Study demonstrates that E15 will not cause or contribute to nonroad engines failing to meet emissions standards.

For addressing immediate exhaust emission impacts, Growth Energy referenced a 1999 SAE report, “The Effect of High Ethanol Blends on Emissions from Small Utility Engines.”[99] The study conducted emissions testing on three MY1994 small (12.5 hp) engines using SAE and EPA procedures. Ethanol was splash blended with a commercial RBOB to produce E0, E10, E25, and E50. The small engine set included two 12.5-hp (9.3 kW gross rating) Briggs & Stratton side-valve engines, and one 12.5-hp Kohler overhead-valve engine. The engines started out running rich on E0, but became leaner with increasing ethanol content. As the ethanol concentration increased, HC and CO emissions decreased, and NOx emissions increased. The emissions results were fully consistent with the observed stoichiometries. Because NOx is regulated by standards for HC+NOx, from a regulatory perspective, the overall emission performance was relatively unaffected by the changes in ethanol content. Growth Energy claims this study demonstrates that E15 should not have any impact on HC+NOx emissions.

Growth Energy did not submit any test data that evaluated how the use of E15 would impact evaporative emissions and evaporative emissions controls for nonroad products, either for immediate emission impacts or long-term evaporative emission impacts (durability).

They did, however, cite the Minnesota Compatibility Study to address potential materials compatibility concerns with E15; materials compatibility issues could also lead to evaporative (short-term permeation or long-term durability) as well as long-term exhaust emission impacts. Growth Energy suggests that the Minnesota Compatibility Study tested commonly used materials in the construction of nonroad engines and that the DOE Pilot Study

[99] Bresenham, D. and Reisel, J. “The Effect of High Ethanol Blends on Emissions from Small Utility Engines,” SAE 1999-01-3345, JSAE 9938100, 1999.

concluded that "no obvious materials compatibility issues were observed during [the] testing" of SNREs.[100] Growth Energy argues that the Minnesota Compatibility Study demonstrates that SNREs should experience no significant materials compatibility problems with E15.

Growth Energy did not provide any data or information quantifying the potential impacts of E15 on the operability or driveability of nonroad products. Instead, they pointed to the DOE Pilot Study discussed above which evaluated long-term emission performance of SNREs. Growth Energy claims that the DOE Pilot Study demonstrates that the use of E15 will not have a discernable impact on the performance and operability of SNREs. They stated that since the DOE Pilot Study shows that the engine performance of SNREs varies considerably regardless of fuel type used that it is not possible to isolate the effects of ethanol on the operability of SNREs.[101]

In their comments, Growth Energy wrote that there "is no scientific basis" for excluding SNREs in a waiver for E15, and further states that the DOE Pilot Study "found no statistically significant impact on operations from higher-blend ethanol, including E-15." Growth Energy also argues that there are no studies that show that E15 will create problems for nonroad engines (marine engines specifically).

C. Public Comment Summary

[100] EPA Docket Number: EPA-HQ-OAR-2009-0211-0002.6: Growth Energy Application, 34.
[101] EPA Docket Number: EPA-HQ-OAR-2009-0211-0002.6:. Growth Energy Application, 34.

AllSAFE and several other commenters argued that the DOE Pilot Study's test program is too small and unrepresentative of the national SNRE population. The commenters pointed out that the DOE Pilot Study only looked at 10 different small spark ignited engines <19kW[102]. The commenters noted that those engines were only from three of the possible seven main classes of SNREs[103]. The commenters stated that in 2008, over 1,000 individual SNREs were certified by EPA, so the 10 engines tested were not comprehensive and nationally representative. Commenters also noted that the DOE Pilot Study itself says that "DOE's test program could focus only on a small subset of these engine families." AllSAFE also argues that the DOE Pilot Study demonstrates that every lawn and garden engine tested showed significant increases in emissions and greater emissions control system deterioration with increasing ethanol levels. Furthermore, AllSAFE points out that the DOE Pilot Study demonstrated higher exhaust temperatures with increasing ethanol levels, which may adversely impact numerous emission-related components, including pistons, crankshafts, gaskets, and catalysts (particularly under off-nominal conditions).

AllSAFE's submittal contained emission results on the testing of a Briggs and Stratton 6.0 horsepower Quantum engine (Class I) on E20 ("Briggs and Stratton Study"). AllSAFE points out that the Briggs and Stratton Study demonstrated that new engine emission testing of the Quantum engine on E20 had an adverse effect on NOx emissions. Exhaust emission testing results on the engine showed a decrease of approximately 32% in HC emissions and an 133%

[102] The study contained two parts; 1) a pilot (new engine) emission study and 2) a study of emissions after a full life durability dynamometer aging. Four different engines were used in the full life durability portion (Briggs & Stratton, Honda, Stihl, Poulan) and multiple engines for each of these were utilized in the study. The multiple engines were used to age different engines on different ethanol blend fuels (E0, E10, E15 and E20).

[103] Small spark ignition engines are grouped into seven Classes and include Class I, Class I-A, Class I-B, Class II, Class III, Class IV and Class V. The engines in the DOE Pilot Study were in Class I, Class II and Class IV for the pilot study and in Classes I and IV for the full life study.

increase in NOx emissions using E20 when compared to E0, which resulted in 10.5% increase in HC + NOx emissions[104].

Many commenters contend that use of E15 in nonroad products causes material compatibility concerns and necessitates further investigation into the impacts of the use of E15 in nonroad engines. Commenters point to two additional studies not cited in Growth Energy's waiver application: (1) an Orbital Study; and, (2) the Briggs and Stratton Study. The Orbital Study is a separate nonroad product study (ie: separate from the Orbital Study on Australian motor vehicles), that conducted 2,000-hour bench testing with E20 on materials from the fuel systems of a Mercury 15hp Marine Outboard engine and a Stihl F45R Line Trimmer ("Orbital Nonroad Products Study"). The Orbital Nonroad Product Study found that E20 caused severe corrosion, rusting and pitting of metallic and brass components, such as the carburetor body and throttle, piston rings, crankshaft seal housing, crankshaft bearings and surfaces, connecting rod, cylinder liner, throttle blades. The study also found that E20 caused swelling, distortion and degradation of the fuel delivery hose, fuel primer bulbs, fuel line connector, and crankshaft seal. The Orbital Nonroad Products Study concluded that these problems would likely cause: 1) oxides that may dislodge and damage the engine; 2) the loss of intended fuel-air metering and control, and 3) fuel leakage.

The Briggs and Stratton Study submitted in Exhibit C of the AllSAFE comments contains evaluations of the impacts of E20 on EPA-certified engines through soaking fuel components[105]

[104] HC reduction estimated from graph while Nox and HC+NOx changes were stated in the report.

[105] The Briggs and Stratton Study stated "A fuel soak test was performed on all parts that come into direct contact with the fuel. These parts include carburetor bodies of zinc and aluminum, brass fuel metering jets, rubber and fiber gaskets, rubber primer bulbs, floats, and fuel bowls." No engine was specifically mentioned.

and this report was cited by other commenters. After six months of soaking, the study showed 5-10% greater swelling and mass gained by gaskets and rubber parts for parts soaked in E20 compared to E0. The epoxy for the Welsch plug, a plug placed over the progression holes in the carburetor body, dissolved in E20 and coated the plug. In a running engine, that could result in the plug falling out and fuel leaking from the carburetor, resulting in a potential increase in evaporative emissions. The inlet needle seats and the fuel cap gaskets swelled, which could also lead to increases in evaporative emissions. Garden tractor fuel tank caps and seals "exhibited extreme swelling" in E20 versus E0.[106] AllSAFE argues that these conclusions corroborate the Orbital Nonroad Products Study's findings and highlight the need for additional research into E15's effects on the materials used in SNREs and other nonroad products.

AllSAFE and others note that the DOE Pilot Study found many issues with SNREs that were not discussed in Growth Energy's waiver application. For example, commenters noted the following problems from the DOE Pilot Study: (1) three Weed Eater blower engines failed, one on E0 and two on E15; (2) one Weed Eater blower would not idle on E20 and (3) another Weed Eater blower would not make full power on E20; (4) a Stihl line trimmer had high idle with E15 and E20 that caused clutch engagement at idle; and (5) a Briggs and Stratton 3500 kW generator stalled and experienced loss of power and abrupt stopping of the engine on E20.

Commenters also point to the operability problems that arose in the Briggs and Stratton Study. In the study, a 6.0 HP Quantum engine was used for temperature, durability and performance, and evaporative testing. AllSAFE and others note that higher operating

[106] It was not clear exactly what parts were used for the fuel soaking tests. It was stated in the study that a 6.0 HP Quantum engine was used, specifically "engine 123K02 0239E1 04061458 was used for all testing except exhaust emissions." However, it was stated that "parts" were soaked, not an engine.

temperatures were observed with increasing ethanol content. The authors say that the higher temperatures caused material compatibility issues, citing a head gasket failure after 25 hours of "very light duty testing."[107] The RPM stability was observed to decrease for both E10 and E20 over E0, with the decrease for E20 close to three times larger than for E10. The stability decrease can lead to harsh audible speed oscillations which may be deemed unacceptable for many applications which require stable engine speeds (e.g., generator, lawn equipment, etc.)[108]. Tests on starting showed a decrease in acceleration using E20 in comparison to E10 and E0.

Several commenters argue that Growth Energy does not provide data concerning the performance of many categories, classes, and families of nonroad engines on E15, and the test data from the DOE Pilot Study is not adequate to cover all nonroad applications. Notable data gaps include information regarding marine engines, snowmobiles, recreational vehicles, motorcycles, and several classes of small nonroad engines that were not tested in the DOE Pilot Study. In addition, several commenters noted, some of the operability issues may pose a significant safety hazard to operators of small nonroad engines due to higher idle speeds and inadvertent clutch engagement.

D. EPA Analysis

1. Scope of Nonroad Data to Support a Waiver Decision

[107] EPA Docket Number: EPA-HQ-OAR-2009-0211-2559.

[108] Generator sets need constant speed in order to provide reliable power for tasks. Lawnmowers require consistent engine speed in order to maintain constant blade tip speed whose top speed is governed by a safety standard.

Prior to assessing the technical merits of the information submitted by Growth Energy to support their waiver application with respect to nonroad products, it is necessary to first assess the completeness of the application. Listed above are four major categories of nonroad engines, and these categories are further broken down into various classes based on the fundamental differences in engine and vehicle design within these classes. EPA has promulgated exhaust and evaporative emission standards for these different categories at various times and these regulations have resulted in various approaches to engine calibration and design[109]. Therefore, to assess the potential impacts of E15 on nonroad products requires data representing the cross section of different nonroad engine categories. EPA highlighted this necessity in discussions with Growth Energy, RFA, DOE, and other stakeholders even prior to the receipt of the E15 waiver application.[110]

The following table summarizes the many potential breakouts of nonroad engine technologies currently in the in-use fleet. Growth Energy gave us data in four areas shown below. Even in areas in which Growth Energy provided data, those data were very limited. Since Growth Energy has not provided information to broadly assess the nonroad engine and vehicle sector, since there are important differences in design between the various classes and categories, and since the Agency is not aware of other information that would allow us to do so, it is not possible for the Agency to fully assess the potential impacts of E15 on the emission performance of nonroad products. In addition, as discussed below, there are reasons for concern with the use of E15 in nonroad products, particularly with respect to long-term exhaust and

[109] *See* Tables in 73 FR 59034, 59036 (10/8/08).
[110] EPA Docket #EPA-HQ-OAR-2009-0211-2559.2, API Technology Committee Meeting, Chicago, 6/4/08.

evaporative emissions durability, and materials compatibility, so the need for data is all the more important.

Table V.D-1: Nonroad Engines and Engine Technologies Over the Past 14 Years

SMALL SI	**Pre-reg: 2- stroke**	**Pre-reg: 4- stroke (ohv/sv)**	**Phase 1: 4- stroke (ohv/sv)**	**Phase 1: 2 stroke w/ cat**	**Phase 2:**	**Phase 2: 2-stroke w/ cat**	**Phase 2: 4 -stroke**	**Phase 3**	**Phase 3 w/ cat**
Class I	X	X ohv X sv	X sv Xohv	-	-	-	**X sv **** **X ohv ****	X sv X ohv	X sv
Class II	-	**X sv **** **X ohv ****	X sv X ohv	-	-	-	X ohv	X ohv	-
Class III	X	-	X	X	-	X	-	-	-
Class IV	X	-	X	X	-	**X ****	**X ****	-	-
Class V	X	-	X	X	-	X	-	-	-
MARINE	**Pre-reg: 2- stroke**	**Pre-reg: 2- Stroke IDI**	**Pre-reg: 4- stroke**	**Phase 1: 2- stroke DI**	**Phase 1: 4-stroke Carb**	**Phase 1: 4-stroke EFI**	**Phase 2: 4-strk closed loop, catalyst**		
Outboard	X	X	X (few)	X	X	X	-		
PWC	X	X	-	X	-	X	-		
SD/I	-	-	X	-	X	X	X		
RECREA-TIONAL	**Pre-reg: 2- stroke**	**Pre-reg: 4- stroke**	**Phase 1: 4- stroke closed crankcase**	**Phase 1: 4- stroke**	**Phase 1: 2-stroke**	**Phase 2: 2-stroke**	**Phase 3: 2-stroke**	**Phase 3: 4- stroke**	
NRMC	X	X	X	X	X*	N/A	N/A	N/A	

Snow Mobiles	X	X	X	X	X	X	X	X	
ATV	X	X	X	X	-	N/A	N/A	N/A	

*NRMC: allows 2-stroke competition bikes

** Data Provided by Growth Energy on one/two engine families per group

2. Long-term Exhaust Emissions (Durability)

Ethanol contains oxygenates which result in a leaner operating A/F ratio. Unlike light-duty vehicles, the overwhelming majority of nonroad engines are "open loop" and do not automatically adjust for oxygenated content of the fuel. Hence they are subject to direct and continuous effects to changes in combustion characteristics (i.e., leaner mixture) of increased ethanol in the fuel which typically result in hotter combustion and exhaust temperatures during operation. These changes in combustion result in general increases in NOx emissions and decreases in HC emissions. This increase in temperature will vary between engines and engine operating conditions. In addition to the NOx emission increases that are observed almost immediately with increased ethanol levels, there is a concern that an increase in temperature can compromise long-term durability of the engines resulting in a significant deterioration of all emissions over time.

The potential for an increase in operating temperatures to cause long-term durability issues for engines is shown in the accelerated full life aging emission results in the DOE Pilot Study[111]. Four new Class I B&S consumer and four new Class I Honda commercial engines

[111] Effects of long term storage and seasonal use were not captured in the accelerated aging.

were aged on non-ethanol and ethanol blends (one engine each on E0, E10, E15 and E20). All engines were tested on non-ethanol fuels when new and at the end of aging on their respective fuel. The change in emissions on non-ethanol fuel gives a basis for comparison of the deterioration effects of aging on various ethanol blend fuels.[112] For the B&S Class I engines, it was found that the non-ethanol aged engine leaned over time with CO decreasing and NOx increasing. For the ethanol aged engine, the increases in CO along with the increases in HC illustrate the possibility of valve warpage and valve seat distortion, or piston/piston ring/engine block distortion due to the increased combustion temperatures. In these cases the combustion becomes less efficient, and hence CO and HC emissions increase, due to the leak past the valves or piston rings. The Honda Class I engine aged on non-ethanol showed small increases in both HC and CO, however the trend was clear in the ethanol engines that the HC and CO emissions increased and NOx decreased in line with increasing amounts of ethanol. Some of the variability in emission results are due to the fact that these engines are mechanically governed, single cylinder (high vibration), carbureted, open loop, air and fuel cooled and hence engine aging is subject to a number of mechanical and quality factors.

The DOE Pilot Study cited by Growth Energy assessed the potential long-term durability emission effects of several SNREs in the <19kW category that were aged under conditions that were representative of aging for emission standards (constant dynamometer aging). While the study was limited and there was considerable variability in the results across the engines tested,

[112] DOE Pilot Study contained data from which the following changes in emissions were calculated. On the B&S consumer engines, the engine aged on non-ethanol fuel had no change in HC, +76% in NOx and -47% in CO. The engines aged on E10, E15 and E20 showed changes in HC of +44%, +149%, +99% and NOx changes of -5%, 0% and 14%, and CO changes of +36%, +109% and +17%, respectively. The Honda commercial engine showed that the engine aged on non-ethanol fuel had emission changes of +25% HC, 0%NOx and 14%CO. The engines aged on E10, E15 and E20: HC: 4%, 42% and 69%, NOx: 11%, -14%, -16% and CO: +5%,+16%,+24%, respectively.

as AllSAFE highlights, the fact that two Weed Eater blower engines failed on E15, a Stihl line trimmer had high idle with E15, and other problems were experienced with testing on E20, suggests the potential for serious durability concerns with E15 in nonroad products. At a minimum, a comprehensive nonroad test program would be needed to support Growth Energy's assertions. We know of no such program underway.

The engine failures in the DOE Pilot Study are also consistent with our engineering assessment. The leaner operation and subsequently hotter burning mixture and exhaust temperatures expose engine components to operating temperatures which may be beyond design expectations for a particular engine. Unlike light-duty vehicles which implement liquid cooling systems (i.e., antifreeze) to control vital engine component temperatures, most nonroad engines rely on air and fuel cooling. Proper cooling on air cooled engines depends on anticipated combustion and exhaust temperatures which are mainly controlled by the A/F mixture. Depending on the engine category, engine cooling may be critical to durability and therefore the ability to continue to operate on E15. Some engines that run too lean for an extended period of time may also result in engine seizure in which the metal of the piston, piston rings and engine cylinder expand into each other due to the increased temperatures and hence cannot function.

While data on long-term durability on E15 of other nonroad categories does not currently exist, we believe that many of the concerns expressed regarding small SI engines may to varying degrees be indicative of other nonroad categories as well. These concerns include concerns of open loop carburetion or open loop fuel injection and enleaned 4-stroke engine running on a fuel with oxygenates where there used to be richer running 2-stroke or 4-stroke engines.

3. <u>Immediate Exhaust Emission Effects</u>

In evaluating the emission impacts of a new fuel or fuel additive, the Agency not only considers potential long-term durability impacts, as discussed above, but also the existence and magnitude of any immediate exhaust emission impacts that are evident immediately upon switching to the new fuel or fuel additive. Growth Energy referred to two studies for immediate tailpipe emission effects and they include the DOE Pilot Study and a 1999 study on “The Effect of High Ethanol Blends on Emissions from Small Utility Engines”.[1]

The DOE Pilot Study contained emissions at new engine condition for two sets of Phase 2 SNRE’s. One set was used for the pilot study and the second set was used for the useful life durability study. The results showed that emission changes from the use of E15 resulted in increased NOx emissions and decreased HC and CO emissions. For both Class I engines the HC and CO emissions decreased and NOx emissions increased in comparison to E0. The overall change of HC+NOx (the form of the emissions standard for nonroad engines) for a particular engine was dependent on whether the NOx increased more than the HC decreased, but in general it appears that the two changes tended to balance each other out for the engines and fuels tested.

Class II engines were examined in a second study[113] referred to by Growth Energy. The study conducted emission testing on three MY1994 SNREs (12.5 hp) engines using SAE and EPA procedures and showed that pre-regulation Class II engines experienced a similar trend with respect to immediate exhaust emission impacts as Class I engines in the DOE Pilot Study. In their comments, AllSAFE also pointed to recent testing described in a Briggs and Stratton Study of exhaust emission testing on a Quantum engine using E20. It showed a decrease in HC emissions and a 133% increase in NOx emissions using E20 when compared to E0, which resulted in 10.5% increase in HC + NOx emissions. While it was on E20 instead of E15, this data is still helpful in showing that despite a very large percentage impact on NOx emissions, the overall immediate emission impact of E15 on the combined HC+NOx emission standard is likely to be a relatively small one. Nevertheless, since the available studies do not provide data for other nonroad engine categories it is unclear how broadly these results can be extrapolated across other nonroad products. Therefore the number of engines and applications tested needs to be widened before any conclusions can be made for all of nonroad products.

4. <u>Evaporative Emissions</u>

Different evaporative emission standards have been established for the different nonroad engine categories. As shown in Tables V.D.4-1 and V.D.4-2 below, evaporative emissions standards for nonroad products are focused on three aspects: (1) fuel line and fuel tank permeation; (2) vapor loss through diurnal or running loss conditions where the volatility of the fuel will be important for compliance; and, (3) the durability of the nonroad product in achieving

[113] Bresenham, D. and Reisel, J. "The Effect of High Ethanol Blends on Emissions from Small Utility Engines," SAE 1999-01-3345, JSAE 9938100, 1999.

these standards over its full useful life. The test fuel for fuel tank permeation is E10 and the test fuel for hose permeation is CE10. The test fuel for the diurnal standards is certification fuel (E0) with a volatility of 9.0 RVP. These standards came into effect in 2007 for Large SI engines, 2008 for recreational vehicles and are being phased in from 2009-2015 for Small SI engines and Marine SI engines. For each of these standards, permeation requirements are based on the use of a test fuel containing 10 vol% ethanol.

Table V.D.4-1 : Large Spark-Ignition Engine Evaporative Emissions Standards

Fuel line permeation	Nonmetallic fuel lines must meet the permeation specifications of SAE J2260 (November 1996)
Diurnal emissions	Evaporative HC emissions may not exceed 0.2 grams per gallon of fuel tank capacity
Running Loss	Liquid fuel in the fuel tank may not reach boiling during continuous engine operation in the final installation at an ambient temperature of 30°C

Table V.D.4-2 : Nonroad Spark-Ignition Engines 19 Kilowatts and Below, Recreational Engines and Vehicles, and Marine Spark-Ignition Engines -- Evaporative Emission Standards[114]

<table>
<tr><th rowspan="2"></th><th rowspan="2" colspan="3">Engine Category</th><th rowspan="2">Model Year</th><th colspan="2">Fuel Line Permeation[a]</th><th rowspan="2">Fuel Tank Permeation ($g/m^2/day$ @ 28°C)</th><th rowspan="2">Running Loss</th><th rowspan="2">Diurnal g/gal/day</th><th rowspan="2">Useful Life [c] (years)</th><th rowspan="2">Warranty Period (years)</th></tr>
<tr><th>Nonroad Fuel Lines ($g/m^2/day$)</th><th>Cold-Weather Fuel Lines [b] ($g/m^2/day$)</th></tr>
<tr><td rowspan="11">Federal</td><td rowspan="8">Small SI Equipment [d]</td><td rowspan="2">Nonhandheld</td><td>Class I</td><td>2012+</td><td>15 [e, f]</td><td>-</td><td>1.5 [f, g, h] (ABT)</td><td>Design Std [i]</td><td>Optional [j]</td><td>5</td><td>2</td></tr>
<tr><td>Class II</td><td>2011+</td><td>15 [e, f]</td><td>-</td><td>1.5 [g, h] (ABT)</td><td>Design Std [i]</td><td>Optional [j]</td><td>5</td><td>2</td></tr>
<tr><td rowspan="6" colspan="2">Handheld (Classes III, IV, &V)</td><td>2010</td><td>-</td><td>-</td><td rowspan="6">1.5 [g, h] (ABT)</td><td rowspan="6">-</td><td rowspan="6">-</td><td rowspan="6">5</td><td rowspan="6">2</td></tr>
<tr><td>2012</td><td rowspan="5">15 [k]</td><td>290</td></tr>
<tr><td>2013</td><td>275</td></tr>
<tr><td>2014</td><td>260</td></tr>
<tr><td>2015</td><td>245</td></tr>
<tr><td>2016+</td><td>225</td></tr>
<tr><td rowspan="3" colspan="3">Marine SI</td><td>2009</td><td rowspan="3">15 [l]</td><td rowspan="3">-</td><td>-</td><td rowspan="3">-</td><td>-</td><td rowspan="3">PWC: 5 All other vessels & portable marine fuel tanks: 10</td><td rowspan="3">2</td></tr>
<tr><td>2010</td><td>-</td><td rowspan="2">0.40 [n]</td></tr>
<tr><td>2011+</td><td>1.5 [g, m] (ABT)</td></tr>
</table>

[114] The complete table is available at http://www.epa.gov/otaq/standards/nonroad/nonroadsi-evap.htm.

	Recreational Vehicles	2008+	15	-	1.5 (ABT)	-	-	5	30 months [o]

***for a full list of footnotes to this table, see http://www.epa.gov/otaq/standards/nonroad/nonroadsi-evap.htm**

[a] Fuel lines used with handheld small spark-ignition (SI) engines installed in cold-weather equipment (as defined in 40 Code of Federal Regulations (CFR) 1054.80) must meet the standards for EPA cold-weather fuel lines.

[e] Nonhandheld fuel line permeation requirements begin January 1, 2009.

Growth Energy did not submit any data that evaluated how the use of E15 would impact evaporative emissions and evaporative emissions controls for nonroad products, and instead relied on light-duty motor vehicle information. The Agency is not aware of any test data to evaluate these impacts of E15 on nonroad products. However, from an engineering standpoint, it would appear that the main concern with the use of E15 in nonroad products for evaporative emissions would be durability, and these concerns stem from materials compatibility concerns in the fuel system, as discussed in the next section. For diurnal emissions compliance, as for light-duty motor vehicles, our belief is that as long as E15 meets the same volatility as E0 certification fuel (9.0 psi RVP), then its emissions performance should be comparable. Testing on vehicles discussed in section IV.A.3. has shown that diurnal emissions are primarily a function of the volatility of the fuel, not the ethanol content, and there is no reason to suggest otherwise for nonroad products. However, due to the rudimentary evaporative emissions controls on most nonroad products, any higher volatility would lead to higher evaporative emissions, potentially causing the nonroad products to exceed their standards. In the case of the permeation related evaporative emissions standards, it is likewise possible that the designs certified for E10 use may also qualify with E15. As discussed in section IV.A.3., permeation testing on light-duty fuel tanks (CRC E77 studies) seems to suggest permeation with E15 may be comparable to that with E10, assuming the RVP will not increase between the two fuels. Since nonroad permeation standards already use E10 as the test fuel, this would suggest that nonroad products would continue to meet their permeation standards with E15. The only question is whether the test results on light-duty motor vehicle fuel systems would be applicable to tanks and hoses used in nonroad products.

5. Materials Compatibility

Materials compatibility is one of the key issues that the Agency reviews due to the potential for very large exhaust or evaporative emission impacts of a fuel or fuel additive, not only in the short-term, but especially over the life of the motor vehicle or nonroad product. Growth Energy argues that the Minnesota Compatibility Study demonstrates that SNREs should experience no significant problems with E15. However, as highlighted by commenters, the focus of the Minnesota Compatibility Study was on the materials used in motor vehicles' fuel systems and that nonroad engine manufacturers use different elastomers, polymers, and plastics not investigated in the Minnesota Compatibility Study. Furthermore, a wide range of materials have been used over the years by the many different nonroad products manufacturers for the many different nonroad products currently in use. The study does not claim to have tested all materials nor provide any means of quantifying the degree to which the materials tested reflect those in the current fleet. Growth Energy contends that the DOE Pilot Study showed no material compatibility issues. However, several commenters note that the DOE Pilot Study's authors point out that materials compatibility issues "were not specifically characterized as part of this study."[115] The Agency's review of the DOE Pilot Study is that the main focus was to measure emissions changes from the use of various fuels in SNREs over a test procedure that lasted 125-500 hours (or 10-40 days at 12.5 hours/day). Materials compatibility issues are mostly seen over

[115] EPA Docket #EPA-HQ-OAR-2009-0211-0335**:** "Effects of Intermediate Ethanol blends on Legacy Vehicles and Small Non-Road Engines, Report 1", October 2008, page 3-12, NREL/TP-540-43543 and ORNL/TM-2008/117.

a length of time of unused fuel sitting in the fuel tank and in the fuel system, and this was not a focus of the study. For the Minnesota Compatibility Study, there was minimal if any applicable information for the vast range of nonroad products and no information to correlate the materials tested with those in the in-use fleet of nonroad products.

Due to the unique chemical and physical characteristics of ethanol, in comparison to gasoline, one must be careful in selecting materials for use in motor vehicles and nonroad products to ensure long-term materials compatibility. Otherwise, materials incompatibility can lead to long-term exhaust and evaporative emission increases that may or may not be detected in certification and compliance testing, as well as product operability problems that could lead to product tampering and premature engine failure.

Two studies cited by commenters serve to highlight the importance of materials compatibility with gasoline-ethanol blends: (1) the Orbital Nonroad Products Study; and (2) the Briggs and Stratton Study. The Orbital Nonroad Products Study conducted 2,000-hour bench testing with E20 on materials from the fuel systems of a Mercury 15hp Marine Outboard engine and a Stihl F45R Line Trimmer. The Orbital Nonroad Products Study found that E20 caused severe corrosion, rusting and pitting of metallic and brass components, such as the carburetor body and throttle, piston rings, crankshaft seal housing, crankshaft bearings and surfaces, connecting rod, cylinder liner, and throttle blades. The study also found that E20 caused swelling, distortion and degradation of the fuel delivery hose, fuel primer bulbs, fuel line connector, and crankshaft seal. The Orbital Nonroad Products Study concluded that these problems would likely cause: (1) oxides that may dislodge and damage the engine; (2) the loss of intended fuel-air metering and control; and (3) fuel leakage.

The Briggs and Stratton Study presented results of a completed evaluation of the impacts of E20 on EPA-certified engines through soaking fuel components. After six months of soaking, the study showed 5-10% greater swelling and mass gained by gaskets and rubber parts for parts soaked in E20 compared to E0. The epoxy for the Welsch plug, a plug placed over the progression holes in the carburetor body, dissolved in E20 and coated the plug. In a running engine, that could result in the plug falling out and fuel leaking from the carburetor, resulting in a potential increase in evaporative emissions. The inlet needle seats and the fuel cap gaskets swelled, which could also lead to increases in evaporative emissions. Garden tractor fuel tank caps and seals "exhibited extreme swelling" in E20 versus E0.[116]

Given the available information to suggest a cause for materials compatibility concerns that could lead to elevated exhaust and evaporative emissions, we do not believe the information provided by Growth Energy adequate addresses materials compatibility for E15 use in nonroad products.

6. Driveability and Operability

E15 will introduce a leaner A/F ratio to the engine compared to motor vehicle gasoline in-use today. The open-loop fuel systems on the nonroad engines will not adjust for this and the

[116] It was not clear exactly what parts were used for the fuel soaking tests. It was stated in the study that a 6.0 HP Quantum engine was used, specifically "engine 123K02 0239E1 04061458 was used for all testing except exhaust emissions." However, it was stated that "parts" were soaked, not an engine.

engines will be subject to potential immediate and long-term operability and drivability issues, such as those described in the DOE Pilot Study.[117] The concern regarding operability and driveability is that if the use of E15 resulted in poor operation of nonroad products, causing such things as misfires, backfires or carburetor malfunctions, then this would cause short-term and long-term emission increases. In addition, it would encourage consumers to adjust and/or tamper with their nonroad products to improve performance. Most nonroad products that have been designed to our emission standards have been required to be tamper resistant to protect the emissions performance of the product. However, this also means that if the nonroad product operates poorly on E15, it will continue to do so, which may increase emissions and shorten its life.

E. Conclusion

It is the burden of the applicant to demonstrate that any new fuel or fuel additive that requires a waiver under CAA section 211(f)(4) of the substantially similar prohibition in CAA section 211(f)(1) will not cause or contribute to the failure of nonroad engines and nonroad vehicles to meet their emissions standards over the engines' or vehicles' full useful life. Growth Energy has not made this demonstration as Growth Energy has not provided sufficient data and information to broadly assess the performance of all nonroad products while using E15. Additionally, based on our own engineering judgment after review of all available data for nonroad products, we find that there are emissions-related concerns with the use of E15 in

[117] The DOE Study of February 2009 on Small SI engines includes information in Table 3.5: A Class I consumer engine was described to lose power at full load on E20 however did run well if more fuel was put into the engine. A Class IV engine was found to have 25% higher idle speed due to the fact that the extra oxygen in the fuel improves combustion and hence speed increases (they do not have speed governors). A Class IV 2-stroke handheld engine seized on E20. A Class I commercial engine showed erratic operation at light loads due to unstable governor.

nonroad products, particularly regarding long-term exhaust and evaporative emissions (durability) impacts and materials compatibility issues. Therefore, the Agency has concluded that it cannot grant a waiver for the use of E15 in nonroad products based on existing data.

VI. Heavy-Duty Gasoline Engines and Vehicles

Given its limited market, heavy-duty gasoline engines and vehicles have not been the focus of test programs and efforts to assess the potential impacts of E15 on such engines and vehicles. From a historical perspective, the introduction of heavy-duty gasoline engine and vehicle technology has lagged behind the implementation of similar technology for light-duty motor vehicles. Similarly, emissions standards for this sector have lagged behind those of light-duty motor vehicles, such that current heavy-duty gasoline engine standards remain comparable, from a technology standpoint, to older light-duty motor vehicle standards (for example Tier 1 emissions standards). Consequently, we believe the concerns raised for MY2000 and older motor vehicles are also applicable to the majority of the in-use fleet of heavy-duty gasoline engines and vehicles. Additionally, Growth Energy did not provide any data specifically addressing how heavy-duty gasoline engines and vehicles' emissions and emissions control systems would be affected by the use of E15 over the full useful life of these vehicles and engines. Thus, a waiver is not being granted for these engines and vehicles.

VII. Highway and Off-Highway Motorcycles

Growth Energy did not provide any data addressing how motorcycle emissions and emissions control systems would specifically be affected by the use of E15 over their full useful life. Like heavy-duty gasoline engines and vehicles, highway and off-highway motorcycles have not been the focus of test programs to evaluate the effects on these motorcycles while using E15. While some newer highway and off-highway motorcycles incorporate some of the advanced fuel system and emissions control technologies that are found in passenger cars and light-duty trucks, such as electronic fuel injection and catalysts, many do not have the advanced fuel trim control of today's motor vehicles that would allow them to adjust to the higher oxygen content of E15. More importantly, older highway and off-highway motorcycles do not have any of these technologies (i.e., their engines are carbureted and/or they do not have catalysts) and are therefore more on par with MY2000 and older motor vehicles and light-duty trucks. Consequently, we believe the discussion for MY2000 and older motor vehicles applies to highway and off-highway motorcycles.

VIII. E12 Midlevel Gasoline-Ethanol Blends

On June 7, 2010, EPA received a letter from Archer Daniels Midland Company (ADM) to consider, within the context of Growth Energy's E15 waiver application, allowing 12 vol% ethanol in gasoline (E12) for the introduction into commerce for all motor vehicles.[118] ADM also requested that EPA modify its "substantially similar" interpretive rule under CAA section 211(f)(1) and allow higher oxygen content, thus allowing for introduction of E12 into the marketplace without need for a waiver. On July 20, 2010, ADM sent a Technical Support

[118] Woertz, P.A. Letter to Lisa P. Jackson. 7 June 2010. See Docket ID EPA-HQ-OAR-2009-0211-13999.

Document (TSD) in support of these requests ("ADM TSD").[119] On September 3, 2010 API submitted its response to both ADM documents, arguing that ADM's analysis contained several critical flaws and suggested that EPA not approve E12 to be introduced into commerce for all motor vehicles.[120] On September 17 and 24, 2010, the Alliance and AllSAFE submitted their own responses with similar arguments.[121] We are treating all of these letters as late comments received on the Growth Energy waiver request application. The following sections address ADM's request and supporting rationale[122], the responses received, and our own analysis regarding ADM's request.

In the ADM TSD, ADM made several arguments for its requests that EPA grant a CAA section 211(f)(4) waiver for E12 and that EPA amend its CAA section 211(f)(1) "substantially similar" interpretive rule and consider E12 "substantially similar" to its certification fuels. For example, in making its argument for granting an E12 waiver, ADM presented some new data, such as evaluations of fuel survey data regarding levels of ethanol in gasoline in the national market today. ADM used their survey results to attempt to evaluate expected emissions impacts and other related issues from using E12 and to conclude that the E12 supposedly now in use in the national gasoline market was not resulting in any motor vehicle problems that adversely affect emissions. ADM also argued that EPA already effectively allows E12 in the marketplace

[119] *Technical Support Document For Archer Daniles Midland Company's Request for Approval of Ethanol-Gasoline Blends of Up To And Including 12 Percent Ethanol, July 20, 2010*, EPA Docket #EPA-HQ-OAR-2009-0211-13995.
[120] CRC Project No. CM-136-09-1B, EPA Docket #EPA-HQ-OAR-2009-0211-14008.
[121] See Docket #EPA-HQ-OAR-2009-0211-14005.1, p.7 and Docket # EPA-HQ-OAR-2009-0211-14004.1, p.3.
[122] In the ADM TSD, ADM in many cases uses data and other information either submitted as part of the Growth Energy application or addressed by EPA above in Section IV for ADM's assertions regarding E12. For example, ADM uses data and information from the Growth Energy application to discuss materials compatibility issues for E12. This data and information has already been evaluated and addressed by EPA in the appropriate sections above. This Section VIII will only address new data and information submitted regarding E12 in the ADM, API, AllSAFE and Alliance submissions that were not previously submitted elsewhere as part of Growth Energy's waiver request application.

through previously issued letters and its models. In making all of these arguments, it appears that ADM was essentially attempting to address the four factors discussed in Section III that EPA analyzes when reviewing a waiver request. In other words, ADM was apparently making these arguments in an attempt to assert that E12 satisfies these four factors so EPA should grant a waiver for E12. EPA generally disagrees with ADM's conclusions and addresses each of these arguments, as well as the comments received on the ADM submission, below.

A. First Argument: E12 is Already Used in the Marketplace with No Reported Problems

1. ADM Argument

In its request, ADM argued that based on surveys and studies, E12 is already in significant use and there have not been any problems reported in-use or in the studies. To support their argument, ADM relied on fuel sample survey data from "selected years and seasons" from the seasonal Northrop Grumman motor gasoline surveys.[123] ADM suggested that these data provide "significant and substantial compelling data demonstrating that ethanol blends approaching E12 are currently available and are being used in the United States without incident".[124] Additionally, ADM argues that around 30% of samples reported in select years and seasons from 1990 through 2009 have denatured ethanol contents greater than 10.5 vol%. ADM specifically cites the summer 2008 Northrop Grumman motor gasoline survey data as showing

[123] See ADM TSD, 5-8.
[124] See ADM TSD, 5.

that over 70% of samples had denatured ethanol contents of higher than 10 vol% ethanol and approximately 30% of samples had 11 vol% or greater denatured ethanol contents.[125]

2. API, AllSAFE, and Alliance Comments

Commenters pointed out that ADM's data is based upon measurements of "denatured" ethanol[126] and that the Northrop Grumman data is actually based upon tests which measure actual ethanol content. Commenters also pointed out that one possible reason for the higher ethanol contents in ADM's analysis may have been an attempt to take the volume of the denaturant into account for each fuel sample. API stated that this may mislead the reader since the pertinent data is actual ethanol or neat ethanol content and inclusion of an assumed denaturant was inappropriate in making the case that higher ethanol contents were routinely in the marketplace.

Commenters also argued that ADM failed to provide any peer-reviewed test program or published test data that shows that the possible prevalence of E12 in some areas did not result in substantial mechanical failures. API and the Alliance also analyzed the Northrop Grumman data and other datasets and concluded that ADM's conclusions about the prevalence of E12 in the marketplace were not accurate. In its submission, AllSAFE aligned itself with these comments.

3. EPA Analysis

[125] See ADM TSD, 5-8.
[126] By regulation denaturant is required to be added to fuel-grade ethanol in order that it not be sold for non-fuel purposes such as the production of beverages.

The Agency evaluated the Northrop Grumman data and found that the actual number of samples that had measured ethanol contents greater than 10 vol% ethanol and 11 vol% ethanol were very low. For example, Figure VIII.A.3-1 below shows the distribution of all fuel samples included in the summer 2008 Northrop Grumman motor gasoline survey that had greater than 5 vol% ethanol.[127]

Figure VIII.A.3-1 – Summer 2008 Distribution of Measured Ethanol Content for Fuel Samples from Northrop Grumman Survey Data

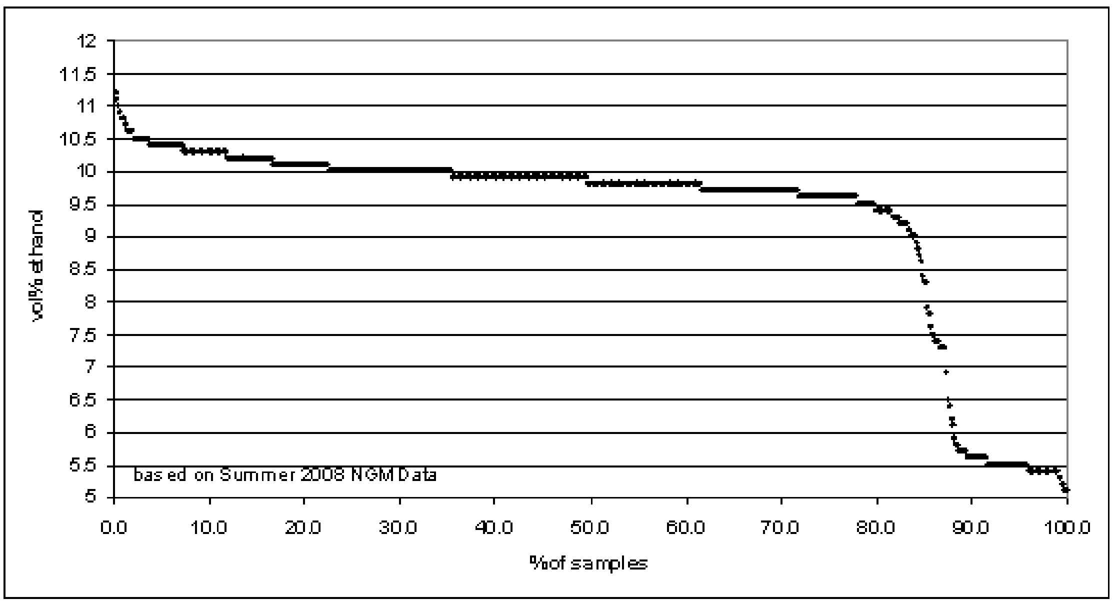


Figure VIII.A.3-1 shows that less than 0.5% of samples in the summer of 2008 had measured ethanol concentrations greater than 11 vol% and only approximately 2% of samples had measured ethanol concentrations greater than 10.5 vol%. Due to inherent variability of the ASTM test procedure used to measure the concentration of ethanol in gasoline (both within the same testing laboratories and between different laboratories), the observed distribution in

[127] We chose to look at only samples that contained greater than 5 vol% ethanol because those appear to be the samples included in ADM's analysis. See ADM TSD, page 8.

measurements of ethanol content is precisely what one would expect to see for fuel samples that actually contained no more than 10 vol% ethanol. Since the blending equipment used at terminals to blend ethanol and other additives into gasoline is extremely precise, and our understanding and experience is that the industry practice is to be as close to 10% as possible, there is no reason to believe that ethanol levels greater than 10 vol% have been experienced in-use except in the infrequent circumstances of blending equipment failure. Recognizing the variability in the ASTM test method results, the Northrop Grumman data actually confirms this to be the case. Had ethanol concentrations actually been at 11 vol% or even 12 vol% in practice, then the variability associated with test measurements would have resulted in some samples measuring as high as 13 vol% or 14 vol%. Such levels have not been seen.

These results are also similar to results using other data sources. Figure VIII.A.3.-2 shows the distribution of ethanol content measurements for the fuel samples containing greater than 5 vol% ethanol collected by the Alliance from 2007 through 2009. Again, these data show the expected distribution of measurements around 10 vol% that one would expect for fuels actually containing 10 vol% ethanol using a test method with significant variability.

Figure VIII.A.3-2: 2007 Through 2009 Distribution of Ethanol Content for Fuel Samples from the Alliance of Automobile Manufacturers Survey Data

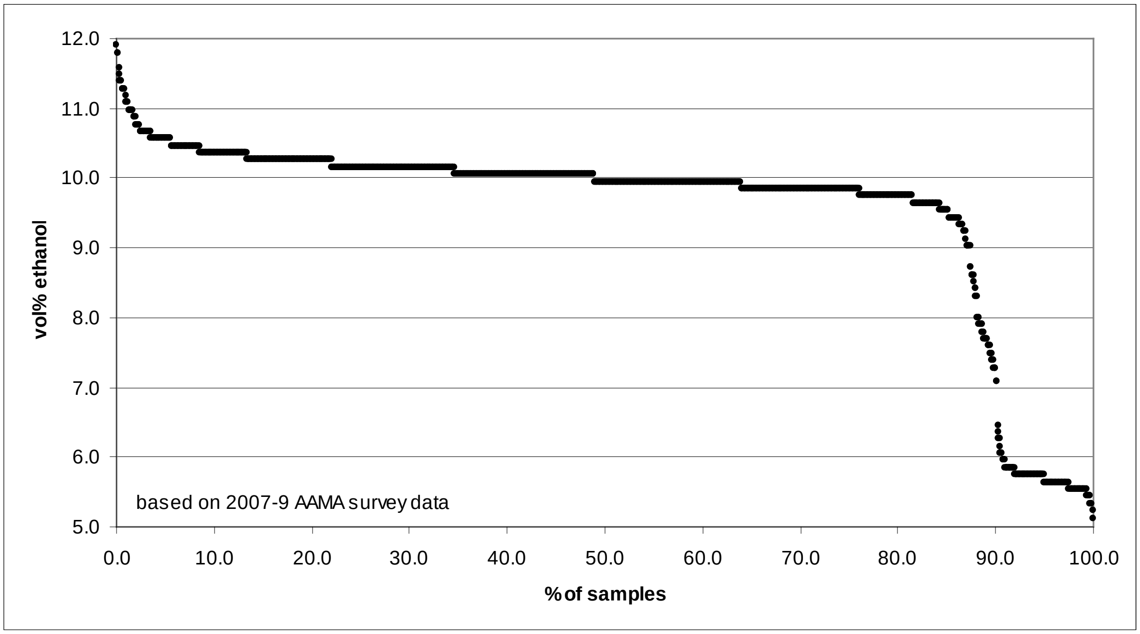
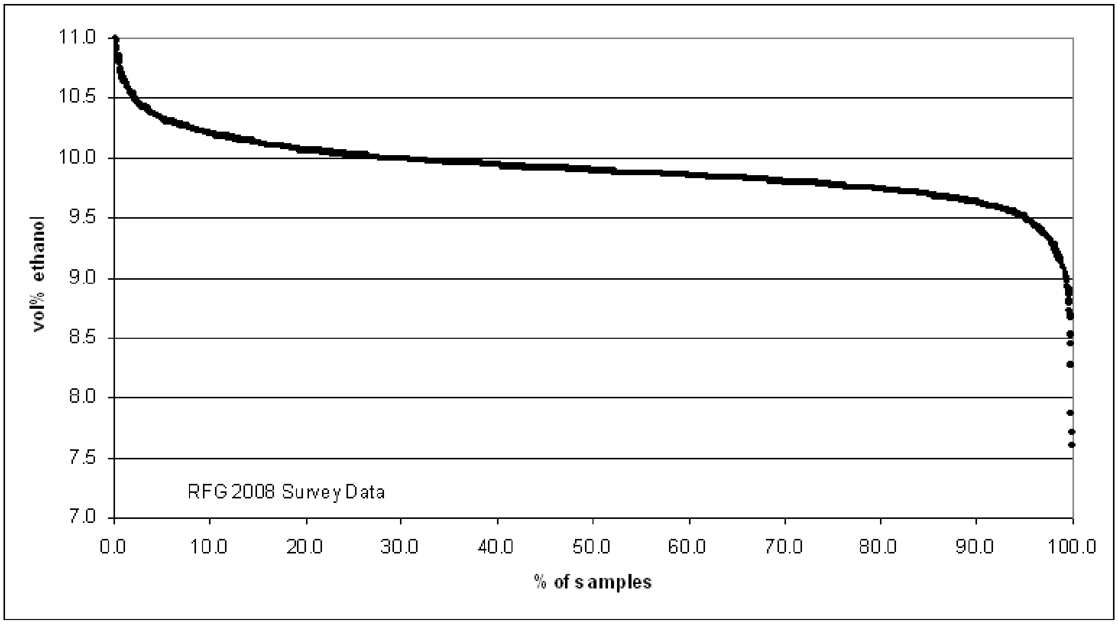


Figure VIII.A.3-3 shows data for summer 2008 from the RFG Survey Program. Although these data do not represent the nation as a whole, they are obtained from a robust survey program designed to estimate RFG fuel parameters. As can be seen, this data shows the same consistent distribution around 10 vol% as the Northrop Grumman and Alliance data.

Figure VIII.A.3-3: Summer 2008 Distribution of Ethanol Content for Fuel Samples from the RFG Survey Program



As highlighted by API, we believe one possible reason for the slightly lower results from our analysis and ADM's analysis is that an attempt may have been made to take the volume of the denaturant into account for each fuel sample. Northrop Grumman reports ethanol content as vol% measured with ASTM 5599; however, ADM describes their analysis in terms of denatured ethanol. Adjusting the ethanol content of samples to include denaturant would shift the distribution and show a higher percentage of fuels containing greater than 10 vol% ethanol.[128] However, the original waiver for E10 allowed for 10 vol% anhydrous ethanol and testing of fuel samples as mentioned above indicate that the full 10 vol% ethanol is actually utilized in making E10. We therefore believe this would be an inappropriate adjustment of ethanol content that may

[128] Since most ethanol is denatured with hydrocarbon mixtures, typically gasoline itself, EPA is unaware how the denaturant content could have been determined if the samples tested were samples of gasoline-ethanol blends.

be misleading since denaturant is typically unleaded gasoline and therefore would not be expected to have an adverse effect on motor vehicles and nonroad products.

Additionally, ADM's analysis of the historical data was not complete. The data selected from the Northman Grumman surveys are limited; for example, the 2005 survey uses only 173 fuel samples and appeared to ignore other fuel samples in the same survey for the same year and also used only selected seasons and years for their arguments. When we look at all the data available, including all the Northrop Grumman data, the Alliance data, and the RFG survey data, in the context of the ASTM test method variability, we conclude that it supports a conclusion that in-use ethanol levels have not exceeded 10 vol%. Otherwise measurements would have been considerably higher.

Furthermore, even if one were to accept ADM's argument that there have been isolated geographically or temporally oriented situations where gasoline-ethanol blends up to and including E12 were in common use for a period of time, ADM has not provided a method of determining or measuring whether problems occurred.

B. Second Argument: EPA Effectively Allows Gasoline-Ethanol Blends Greater than E10

1. <u>ADM Argument</u>

ADM also argued that EPA guidance at various times in the late 1980s and 1993 indicated EPA's allowance for gasoline-ethanol blends containing greater than 10 vol% ethanol. ADM sites three letters from EPA in support of their argument.[129] For the first two letters, ADM's argument was based on EPA-stated oxygen contents for average E10 gasoline-ethanol blends or maximum oxygen contents for E10 blends. With respect to the third letter, ADM argued that by allowing contaminant levels of MTBE in gasoline for ethanol blending, EPA was endorsing the intentional "stacking" of 10 vol% ethanol on top of gasoline with up to 2 vol% MTBE, thus allowing for higher oxygen levels equivalent or nearly equivalent to E12. ADM then argues that the letters essentially were an EPA allowance to utilize up to 11.7 vol% ethanol.

2. <u>EPA Analysis</u>

ADM inappropriately concludes that EPA was approving ethanol content above 10 vol% in the first two letters. These two letters merely stated various oxygen weight contents as estimates of the weight percent of oxygen in a 10 vol% gasoline-ethanol blend, depending upon the density of the gasoline into which the ethanol was added.[130] Neither EPA letter states, nor was there any intention conveyed, that it was legal to blend ethanol above 10 vol% into unleaded gasoline.

[129] See ADM TSD, 9.
[130] Gasoline densities typically vary seasonally and geographically to account for varying performance requirements such as variations in requirements for cold and hot weather or high-altitude regions. The oxygen content of 10 vol% ethanol in gasoline varies as the density of the gasoline into which it is blended varies. For example, when 10 vol% ethanol is added to a relatively low-density winter gasoline, the oxygen content from the ethanol will be relatively heavier than when the same ethanol is added to a heavier or higher density summertime fuel.

In the third letter, EPA had recognized how ubiquitous MTBE had become in the fungible gasoline distribution system, including in pipelines and terminals. The allowance for very small amounts of MTBE in gasoline to be blended with ethanol (so-called "stacking") was allowed to address the ubiquitous presence of MTBE in some fungible systems at that time, making it a low-level contaminant for gasoline used in E10. Typically the MTBE was in trace amounts in gasoline and was not close to 2 vol%. The letter recognized this as a contaminant so that it would not be unlawful to add up to 10 vol% ethanol into the base gasoline. Refiners were not permitted to intentionally produce a gasoline using 2 vol% MTBE and 10 vol% ethanol. EPA has not stated that it is permissible to utilize over 10 vol% ethanol under the original ethanol waiver and the data discussed above shows that, in practice, it is only rarely (and impermissibly) used above 10 vol%.[131]

C. Third Argument: EPA's Models Allow Greater than 10 vol% Ethanol

1. <u>ADM Argument</u>

ADM further argued that E12 is implicitly allowed by virtue of the oxygen limits allowed in the Complex Model. ADM argued that since the Complex Model[132] provides valid emissions results for a fuel with up to 4% oxygen by weight (wt%), and E12 is "close" to this weight

[131] Although very small amounts of oxygen were added when trace contaminant amounts of MTBE were allowed when such gasoline had been inadvertently added to 10 vol% ethanol, MTBE would, in any event, have different effects on vehicles/engines in that it is a less polar molecule resulting in different impacts regarding materials compatibility.

[132] The "Complex Model" is a regulatory model used to predict the emissions effects of various gasoline properties, including oxygen content.

percent limit since it represents 4.2 wt% to 4.4 wt% in gasoline, EPA, through this model, has effectively already allowed use of E12.

2. API and Alliance Comments

API pointed out that the 4 wt% oxygen limit was meant as a range limit, taking into account the variability of densities that exist in gasoline across the nation. API states that "ADM…twists the logic stated by EPA in 1994 for increasing the high end of the valid range for fuel oxygen content to 4.0 wt% in the RFG Complex Model. ADM asserts that this action by EPA meant that it had 'already authorized' the use of E11.7 vol% gasoline-ethanol blends. This interpretation confuses the issue of weight percent oxygen in the final gasoline-ethanol blend versus the volume percentage of ethanol added to the fuel. ADM acknowledges that the density of the base hydrocarbon blend stock (BOB) is critically important in the weight percent calculation, but then totally ignores it. To translate from 4.0 wt% oxygen to 11.7 vol%**,** ADM had to have made an assumption regarding the BOB density, but it fails to provide any information as to the nature and/or basis for it."[133]

API goes on to state that "EPA's 1994 ruling did not 'authorize' the use of E11.7, it simply recognized the range of BOB densities that exist in commerce and allowed for the resulting wt% oxygen that might be observed with E10. In fact, a careful reading of the 1994 regulatory text reveals that there is not one shred of evidence that even hints at the possible consideration (in 1994) of gasoline-ethanol blends containing greater than 10 vol%." The Alliance specifically aligned itself with the comments on this issue from API.

[133] See API Comment, Docket #EPA-HQ-OAR-2009-0211-14000.1, 2.

3. <u>EPA Analysis</u>

We do not agree with ADM's argument. The 4 wt% oxygen limit in the Complex Model was meant as a range limit on the weight of oxygen in the gasoline-ethanol blend, taking into account the variability of densities that exist in gasoline across the nation. It did not change the 10 vol% limit for ethanol use in gasoline. It recognized that the same volume percent of ethanol may lead to different weight percents of oxygen in the gasoline-ethanol blend, based on the density of the gasoline. The Complex Model is designed to allow a valid emissions projection for purposes of the Reformulated Gasoline program for the full range of ethanol and other blends of fuels that lawfully could be produced. It did not change any of the requirements that fuels otherwise had to meet to be a lawful fuel. Specifically, it did not change the requirement that gasoline-ethanol blends could only be lawfully produced at no higher than 10 vol% ethanol. The range of the Complex Model would then potentially cover the range of wt% oxygen that could occur for a finished gasoline-ethanol blend that had no more than 10 vol% ethanol.

D. Fourth Argument: ADM's Argument for an E12 Waiver

1. <u>ADM Argument</u>

ADM reiterated its support of the Growth Energy request and argued that E12 should be considered under the Growth Energy waiver application and that a waiver should be granted for

E12. The primary basis of ADM's argument relied on studies and materials that had already been submitted under the Growth Energy waiver request application.

ADM provided reference to a number of engineering papers which noted the similarity in effects on elastomers and plastics for E12 when compared to E10. ADM also made many arguments which were essentially the same as the arguments made for the Growth Energy application regarding exhaust and evaporative emissions effects, materials compatibility and driveability/operability on motor vehicles and small engines. These studies, and the arguments, essentially mirrored arguments already considered in the context of the Growth Energy application discussed above.

ADM also utilized the survey data it had presented to attempt to make conclusions regarding the emissions effects of E12. For example, ADM tried using the Complex Model to predict emissions for E12 based upon changes in properties if 12 vol% ethanol was added to gasoline.

2. <u>API, AllSAFE and Alliance Comments</u>

API rejected the ADM arguments. API stated that ADM's arguments were erroneous because the studies cited were misinterpreted, already presented in the Growth Energy application, or based upon flawed survey data. API also pointed out that the Complex Model, used for predicting emissions, is based only upon 1990 technology motor vehicles and that ADM's emissions predictions made assumptions about fuel composition after the addition of 12 vol% ethanol that were not supported by any analysis. AllSAFE also pointed out that the ADM TSD attempted to extrapolate the effects of E12 based on the effects of lower levels of ethanol content found in gasoline-ethanol blends, and argued that this is not an adequate substitute for the actual testing of E12.

3. EPA response

To address ADM's arguments, we refer to our discussion of immediate and long-term (durability) exhaust and evaporative emissions impacts, materials compatibility and driveability found in Section IV regarding the Growth Energy waiver application. EPA's analysis above regarding the Growth Energy waiver request application covers the range of gasoline-ethanol blends that include blends above 10 vol% and no more than 15 vol% ethanol. Additionally, we note that ADM's analysis of survey data is flawed in that EPA's analysis indicates that there is no evidence of E12 in the marketplace today. ADM also does not present any process by which any effects of E12 in the marketplace could be evaluated. EPA agrees with API's comments regarding the use of the Complex Model to evaluate projected emissions changes; such use is inappropriate for a waiver decision. ADM's arguments are based upon flawed use of the survey data, inappropriately used models, issues and data already discussed within the context of the Growth Energy application, interpolation of data and effects from studies that did not specifically investigate the effects of E12, or studies that included insufficient data to make the conclusions ADM stated. Furthermore, many of ADM's arguments involving interpolation or comparison of data compared E12 to E10 where the appropriate comparison for meeting the criteria of a waiver would be appropriately made between E12 and E0. Most importantly, the data presented by

ADM did not present any data on which a conclusion regarding the long-term emissions effects of E12 could be based. ADM provides no additional information on E12 that would change our evaluation regarding a waiver for gasoline-ethanol blends over 10 vol%.

Thus, EPA concludes, after review of the information provided by ADM, and based on the data received regarding the E15 waiver request, that there is insufficient basis to support the introduction into commerce of E12 for use in all motor vehicles and nonroad products. Specifically, our analysis for gasoline-ethanol blends up to 15 vol% ethanol has concluded that there is insufficient data or evidence to grant a waiver beyond MY2007 and newer light-duty motor vehicles. ADM did not provide any data regarding motor vehicle exhaust or evaporative emissions using a 12 vol% gasoline-ethanol blended fuel. Also, EPA is not aware of any test data using 12 vol% gasoline-ethanol blends that would support this request beyond MY2007 and newer light-duty motor vehicles. EPA has determined that there is an inadequate demonstration for an E12 waiver application for MY2000 and older motor vehicles, heavy-duty gasoline engines and vehicles, highway and off-highway motorcycles and for all nonroad products. EPA is deferring a decision for MY2001-2006 motor vehicles.

E. Fifth Argument: E12 is "Substantially Similar" to Certification Fuel

1. ADM Argument

ADM's final argument is that since E10 is used as an aging fuel for evaporative emissions service accumulation purposes in EPA's emissions certification regulations, E10 is a “certification fuel” for purposes of the CAA section 211(f)(1) “substantially similar” determination. ADM further asserts that E12 is “substantially similar” to E10 based on its chemical and physical properties, so EPA should revise its “substantially similar” interpretive rule and increase the “substantially similar” oxygen limit from 2.7% by weight to 4.25% by weight.

2. <u>API, AllSAFE and Alliance Comments</u>

The Alliance commented that E10 is only used for certification purposes regarding the aging of motor vehicles for evaporative emissions certification; E10 is not used in any of the actual emissions certification tests. The Alliance points out that “ADM bases this argument on the fact that EPA requires manufacturers to use the highest gasoline-ethanol blend for evaporative system durability aging in the certification process. Unfortunately, ADM either misunderstands or has misrepresented the vehicle certification process. Importantly, this particular requirement applies only to evaporative emissions system aging; it has no connection to exhaust emission testing.” The Alliance concludes that “ADM's assertion that this fuel qualifies as a certification fuel for the entire fleet is simply untrue.”[134] AllSAFE’s comments essentially agree with this interpretation, noting that “consistent with the focus of [section] 211(f)(4) on emissions control devices, Congress must necessarily have intended certification fuels to refer to emissions certification fuels, not mileage accumulation fuels.” API also agreed that the ADM submission did not support a conclusion that E12 is substantially similar to certification fuel and pointed out that ADM presents no emissions data on E12.

[134] See Alliance Comments Docket #EPA-HQ-OAR-2009-0211-14004.1, 9-10.

3. EPA Response

In evaluating ADM's request to revise the definition of "substantially similar," EPA considered all certification fuels used for the broad range of motor vehicle model years, not just the current model years, and considered both the exhaust and the evaporative emissions certification procedures. This is because the "substantially similar" definition affects roughly 300 million motor vehicles which represent thousands of different designs by a wide range of manufacturers from around the world. These motor vehicles are in a transportation system and marketplace that affects the entire country. Based on these considerations, EPA does not believe that E10 qualifies as a "certification fuel" in the manner asserted by ADM such that it would be appropriate to compare E12 to E10 in determining whether E12 is "substantially similar" for a CAA section 211(f)(1) determination. E10 is only used in one part of the certification process for certain newer motor vehicles. Specifically, E10 is only used in the mileage-accumulation or aging portion of certification for evaporative emissions for Tier 2 vehicles. However, all exhaust and evaporative emissions testing for certification purposes is conducted using an E0 fuel. Thus, E10 plays a limited role in the certification process for a limited subset of motor vehicles. In contrast, E0 has been and remains the primary fuel used in certification since it is the actual test fuel for all of the actual emissions standards testing required for certification. Thus, it would be inappropriate to consider E10 a "certification fuel" for comparison with E12 in making a "substantially similar" determination as requested by ADM. The proper comparison is between E12 and E0.

In making a "substantially similar" determination, EPA generally evaluates the physical and chemical composition of the new fuel or fuel additive against our certification fuels to determine the emissions effects of that new fuel or fuel additive. Here, we find that E12 is not "substantially similar" physically or chemically to E0. As is noted in today's Decision, E12 has a substantially higher oxygen content than E0, and the polarity of the ethanol molecule results in various properties different from those of E0, such as differences in polarity and volatility. Such differences may affect emissions and the durability of motor vehicle components. Consistent with our prior revisions to the "substantially similar" definition, and prior "substantially similar" determinations, we would also consider test data on the emissions effects of E12, as with a waiver request, in making this determination.[135] For E12, we would evaluate whether the higher oxygen content would produce similar emission results as E0 under the certification process. ADM provided no such data and we are not aware of any test data using 12 vol% ethanol blends. Based on the physical and chemical differences between E12 and E0, and the absence of a showing of the emissions impacts when using E12 versus using E0, EPA finds no basis for revising the "substantially similar" definition to include E12.

F. EPA Conclusion

For MY2007 and newer light-duty motor vehicles, EPA has concluded that there is an adequate demonstration for an E12 partial and conditional waiver, within the context of the Growth Energy E15 waiver request application, as discussed above in Section IV. For MY2000

[135] For example, when EPA revised its substantially similar definition in 1991 under which the allowable oxygen content was raised to 2.7% by weight for certain alcohol and ether oxygenates (56 FR 5352, February 11, 1991), there was a long history of use and a large database to draw from regarding the use of oxygenates at these levels. As discussed above, EPA does not believe the data shows that E12 has, in fact, been routinely used in the marketplace and independent testing on E12 is not available.

and older motor vehicles, heavy-duty gasoline engines and vehicles, highway and off-highway motorcycles, and all nonroad products, EPA has concluded that there is insufficient evidence to grant a waiver. EPA is deferring a decision for MY2001-2006 light-duty motor vehicles.

EPA has also concluded that ADM has not made a demonstration that E12 is "substantially similar" to certification fuels, and EPA declines to amend its "substantially similar" interpretive rule to include E12.

IX. Legal Issues Arising in this Partial Waiver Decision

A. Partial Waiver and Conditions of E15 Use

As stated in EPA's notice for comment on the E15 waiver request, a possible outcome after the Agency reviewed the record of scientific and technical information may be an indication that a fuel up to E15 could meet the criteria for a waiver for some vehicles and engines but not for others. In this context, the Agency noted that one interpretation of section 211(f)(4) is that the waiver request could only be approved for that subset of vehicles or engines for which testing supports its use. We also stated that such a partial waiver for use of E15 may be appropriate if adequate measures or conditions could be implemented to ensure its proper use. EPA invited comment on the legal aspects regarding a waiver that restricted the use of E15 to a subset of vehicles or engines, and the potential ability to impose conditions on such a waiver.

We received a number of comments expressing opposition to a partial waiver based on a lack of legal authority under section 211(f)(4). Some of those same commenters, as well as others, also stated that EPA should *first* conduct and finalize a rulemaking under section 211(c) to mitigate the potential for misfueling and limit the types of mobile sources for which E15 may be used.

Many commenters pointed to the language in section 211(f)(4) and argued that the use of the word "any" in the phrase "will not cause or contribute to a failure of any emission control device or system (over the useful life of the motor vehicle, motor vehicle engine, nonroad engine or nonroad vehicle in which such device or system us used) to achieve compliance by the vehicle or engine," means that if the waiver applicant has not established that the use of E15 meets the waiver criteria for *any* type of motor vehicle or nonroad product, then the waiver must be denied. Noting the statutory provision's use of the word "any," commenters asserted that should E15 cause or contribute to a failure of *any* emission control device to achieve compliance under *any* single circumstance, then the waiver applicant has not met the waiver criteria and the waiver must be denied in its entirety. Another commenter suggested that the word "any" modifies "emission control device" and that if an emission control device for *any* of the types of vehicles in the parenthetical language in section 211(f)(4) is implicated, then the waiver must be denied. Still another commenter suggested that "In amending section 211(f)(4) in 2007 with enactment of the Energy Independence and Security Act, Congress expanded the types of devices for which an applicant must establish that a fuel or fuel additive will not cause or contribute to a failure while retaining the prohibition of causing or contributing to the failure of 'any' device. With the expansion of section 211(f)(4), EPA is directed to only approve a waiver if all nonroad and on-road vehicles and engines would not be adversely affected." Commenters asserted that the provision effectively required that there should be a "general purpose" fuel. The commenters noted that EPA would contradict this direction if it failed to address impacts on any portion of the vehicles or engines. Essentially, the implication of all of these assertions is that EPA can only grant a waiver if *all* emission control devices in *all* types of mobile sources listed in the statute will not be adversely impacted by E15.

We also received several comments suggesting that if EPA desires to grant a partial waiver, it must first proceed under section 211(c) with a separate and full rulemaking to analyze the costs, benefits, necessary lead time, and the technological feasibility of a partial waiver. The commenters stated that this rulemaking should also include an analysis of the partial prohibition and controls on the use of E15 and include detailed regulatory requirements to ensure adequate control measures and to mitigate misfueling with E15. Commenters stated that the inclusion in section 211(f)(4) of 270 days by which EPA must act does not allow enough time to address all the necessary marketing and other issues and thus Congress could not have envisioned a partial waiver.

Growth Energy and ACE stated that the Agency has the authority to grant a partial waiver or that EPA's authority for a partial waiver is a permissible interpretation of CAA authority, but that the evidence suggests a waiver for all vehicles and engines on the road today is appropriate.

We also received comment noting that the prohibition in section 211(f)(1) only applies to the use of any fuel or fuel additive in light-duty motor vehicles, indicating that the grant of the waiver of this prohibition under section 211(f)(4) is not dependent on findings with respect to nonroad products. The commenter further noted that although EPA has the authority and discretion to look at the effect of a fuel or fuel additive on nonroad products (in the context of examining impacts on motor vehicles), nothing in the statute or legislative history indicates that the amendment to section 211(f)(4) sought to limit EPA's discretion for issuing a waiver for motor vehicles. In light of Congress' decision in the Energy Independence and Security Act of 2007 to substantially increase the Renewable Fuel Standard Program's volume mandates, this commenter suggests that reading the word "any" in section 211(f)(4) as amended by the 2007 Energy Act to apply to anything more than any emission control systems on the subset of motor vehicles would be at odds with congressional intent.

Regarding EPA's authority to impose conditions on a waiver, we received comment stating that EPA has the authority to grant waivers subject to a broad range of conditions that ensure that the fuel or fuel additive will not cause or contribute to the failure of any emission control device or system. One commenter pointed to four of the eleven waivers EPA has issued since 1977 that have placed conditions on a waiver.[136] In EPA's first waiver decision in 1978, the Agency discussed its authority to grant conditional waivers, noting that it may grant a waiver

[136] *See* Sun Petroleum Products Co.; Conditional Grant of Application for Fuel Waiver for 0-5.5% methanol/TBA, 44 Fed. Reg. 37,074 (June 25, 1979); E.I.DuPont de Nemours & Co.; Conditional Grant of Application for Fuel Waiver for 5% methanol/2% cosolvent alcohols, specified corrosion inhibitor, Decision Document, 51 Fed. Reg. 39,800 (Oct. 31, 1986); Texas Methanol Corp.; Conditional Grant of Application for Fuel Waiver for Octamix (5% methanol, 2.5% cosolvent alcohols, specified corrosion inhibitor), Decision Document, 53 Fed. Reg. 33,846 (Sept. 1, 1988); Sun Refining and Marketing Co.; Conditional Grant of Application for Fuel Waiver for 15% MTBE, Decision Document, 53 Fed. Reg. 33,846 (Sept. 1, 1988). These conditions have taken various forms, from restrictions on the chemical composition and additive concentration of the waiver fuel and requirements to meet ASTM and seasonal volatility standards, to specific testing protocols and mandates that a fuel manufacturer take "all reasonable precautions" to guard against unauthorized uses of the waiver fuel.

“conditioned on time or other limitations,” so long as “the requirements of section 211(f)(4) are met.”[137] This commenter also points to the legislative history of section 211(f)(4) which makes clear that EPA has authority to grant conditional waivers. The 1977 Senate Report regarding section 211(f)(4) states: “The Administrator’s waiver may be under such conditions, or in regard to such concentrations, as he deems appropriate consistent with the intent of this section.” Senate Report No. 95-125, 95th Congress, 1st Session 91 (1977), pg 91.

The issue before EPA is whether it is reasonable to interpret section 211(f)(4) as authorizing EPA to grant a partial waiver under appropriate conditions, as in today’s decision. If Congress spoke directly to the issue and clearly intended to not allow such a partial waiver, then EPA could not do so. However, if Congress did not indicate a precise intention on this issue, and we believe that section 211(f)(4) is ambiguous in this regard, then a partial waiver with appropriate conditions would be authorized if it is a reasonable interpretation. EPA has considered the text and structure of this provision, as well as the companion prohibition in section 211(f)(1), and believes it is a reasonable to interpret section 211(f)(4) as providing EPA with discretion to issue this partial waiver with appropriate conditions.

It is important to put section 211(f)(4) in its statutory context. The prohibition in section 211(f)(1) and the waiver provision in section 211(f)(4) should be seen as parallel and complementary provisions. Together they provide two alternative paths for entry into commerce of fuels and fuels additives. The section 211(f)(1) prohibition allows fuels or fuel additives to be introduced into commerce as long as they are substantially similar to fuel used to certify

[137] *See* Ethyl *Corp*., Denial of Application for Fuel Waiver for MMT (1/16 and 1/32 gpg Mn), 43 Fed. Reg. 41,424 (Sept. 18, 1978).

compliance with emissions standards, and the section 211(f)(4) waiver provision allows fuels or additives to be introduced into commerce if they will not cause or contribute to motor vehicles and nonroad products to fail to meet their applicable emissions standards. EPA's authority to issue a waiver is coextensive with the scope of the prohibition – whatever is prohibited can also be the subject of a waiver if the criteria for granting a waiver are met. In addition, the criteria for each provision have similar goals. They are aimed at providing flexibility to the fuel and fuel additive industry by allowing a variety of fuels and fuel additives into commerce, without limiting fuels and additives to those products that are identical to those used in the emissions certification process. This flexibility is balanced by the goal of limiting the potential reduction in emissions benefits from the emissions standards, even if some may occur because a fuel or fuel additive is not identical to certification fuel or it leads to some emissions increase but not a violation of the standards. Together, these are indications that these provisions are intended to be parallel and complementary provisions.

The section 211(f)(1) prohibition has evolved over time. Initially it was adopted in the 1977 amendments of the Act, and was much more limited in nature. It applied only to fuels or fuel additives for general use, and was also limited to fuels or fuel additives for use in light-duty motor vehicles. EPA interpreted this as applying to bulk fuels or fuel additives for use in unleaded gasoline. The prohibition did not apply to other gasoline, or to diesel fuels or alternative fuels, or to fuel additives that were not for bulk use. It was thus relevant only to the subset of motor vehicles designed to be operated on unleaded gasoline.

In 1990 Congress amended the prohibition and broadened it. It now applies to "any fuel or fuel additive for use by any person in motor vehicles manufactured after model year 1974 which is not substantially similar to any fuel or fuel additive utilized in the certification of any model year 1975, or subsequent model year, vehicle or engine." This extended the scope of the prohibition to apply to all gasoline, to diesel fuel, and to other fuels such as E85. However, the concept of applying this prohibition based on the relevant subset of vehicles continues. For example, a diesel fuel that is introduced into commerce for diesel vehicles does not need to be substantially similar to gasoline fuel or other fuels intended for non-diesel vehicles. This is so even though Congress used the phrase "substantially similar to <u>any</u> fuel or fuel additive utilized in the certification of <u>any</u>…vehicles or engine" (emphasis supplied). Clearly Congress did not intend the use of the term "any" in the prohibition to always mean all motor vehicles or 100% of the motor vehicle fleet. Diesel fuel does not need to be substantially similar to the fuel used in the certification of gasoline vehicles, and E85 does not need to be substantially similar to fuel used in the certification of diesel vehicles. For example, manufacturers who want to introduce E85 fuel or fuel additives for E85 look to the certification fuel that was used for the subset of vehicles that were certified for use on E85.

In some limited cases, EPA has approved a fuel additive as substantially similar even when it is introduced into commerce for use in just one part of a single vehicle manufacturer's product line. For example, where a fuel additive is considered part of the emissions control system for a vehicle model, and is certified that way by the vehicle manufacturer, then it is not a violation of the substantially similar prohibition for manufacturers of the fuel additive to introduce it into commerce for use in just that very small subset of vehicles as long as it is substantially similar to the fuel additive used in the certification of that vehicle model.[138] In all of these cases, broad to narrow subsets of motor vehicles can be considered when deciding whether the introduction of a fuel or fuel additive for use by that subset of motor vehicles is in compliance with the prohibition.

EPA has in fact applied this construct of this provision in all of its past waiver decisions. EPA has previously said that it is virtually impossible for an applicant to demonstrate that a new fuel or fuel additive does not cause or contribute to *any* vehicle or engine failing to meet its emissions standards. Instead, EPA and the courts allow applicants to satisfy this statutory provision through technical conclusions based on appropriately designed test programs and properly reasoned engineering judgment.[139] For example, the sample size in these test programs does not include *all* motor vehicles in the current fleet; the sample size is comprised of a statistically significant sample of motor vehicles that, once tested, will enable the applicant to extrapolate its findings and make its demonstration. EPA believes that this practice of focusing on a relatively small but representative subset of motor vehicles does not violate the statutory use of the word "any" in this provision.

Since the waiver and the substantially similar provisions are parallel and complementary provisions, this clearly raises the question of whether a waiver can also be based on a subset of motor vehicles meeting the criteria for a waiver. EPA believes the text and construction of section 211(f)(4) supports this interpretation.

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[138] *See* 54 FR 4834 (November 22, 1989).
[139] *See* 44 FR 10530 (February 21, 1979); *Motor Vehicle Mfrs. Ass'n. et. al. v. EPA*, 768 F.2d 385 (D.C. Cir. 1985).

First, the term “waive” as used in section 211(f)(4) is not modified in any way. Normally one would read this provision as a general grant of waiver authority, encompassing both partial and total waivers, as long as the waiver criteria are met. Second, the waiver criteria, like section 211(f)(1), have evolved over time. In 1977, the criteria were phrased as providing for a waiver when the fuel or fuel additive “will not cause or contribute to a failure of any emission control device or system (over the useful life of any vehicle in which such device or system is used) to achieve compliance by the vehicle with the emission standards to which it has been certified.” This was not modified in the 1990 amendments. In EISA 2007, Congress amended the waiver criteria, providing for a waiver when the fuel or fuel additive will not “cause or contribute to a failure of any emission control device or system (over the useful life of the motor vehicle, motor vehicle engine, nonroad engine or nonroad vehicle in which such device or system is used) to achieve compliance by the vehicle or engine with the emission standards to which it has been certified.” Congress uses the term “any” in section 211(f)(4), as it does in several places in section 211(f)(1). One use of the term “any” was deleted in the 2007 amendments, when the parenthetical was broadened to include consideration of nonroad engines and nonroad vehicles as well as motor vehicles. The term “any,” however, has always been paired with the consistent use of the singular when referring to vehicles and emissions control systems–“the vehicle” and the emissions standards to which “it” is certified, and the “vehicle in which such device or system is used.” Certainly Congress did not state that the applicant has to demonstrate that the fuel or fuel additive would not cause *any* devices or control systems, over the useful lives of the motor vehicles or nonroad products in which they are used, to fail to achieve the emissions standards to which they are certified. If Congress had stated that, then it would be clear, as one commenter suggests, that EPA should only grant a waiver if *all* emission control devices in *all* the types of mobile sources listed would not be impacted by the fuel. But Congress did not state that.[140]

Several aspects of section 211(f) thus support the reasonableness of EPA's interpretation. The prohibition and the waiver provisions are properly seen as parallel and complementary, and the prohibition properly can be evaluated in terms of appropriate subsets of motor vehicles, notwithstanding the use of the term "any" to modify several parts of the prohibition. This clearly raises the concept of also applying the waiver criteria to appropriate subsets of motor vehicles. "waive" is reasonably seen as a broad term that generally encompasses a total and a partial waiver, as well as the discretion to impose appropriate conditions. The criteria for a waiver also refer to "any" but the entire provision does not provide a clear indication that Congress intended to preclude consideration of subsets of motor vehicles when considering an application for a waiver. Finally, a partial waiver gives full meaning to all of the provisions at issue.

For example, in this case, granting a partial waiver means that E15 can be introduced into commerce for use in a subset of motor vehicles, MY2007 and newer light-duty motor vehicles, and only for use in those motor vehicles. For those motor vehicles, EPA is not making a finding of it being substantially similar, but E15 has been demonstrated to not cause or contribute to these motor vehicles exceeding their applicable emissions standards. It will also not cause any other motor vehicles or any other on or off-road vehicles or engines to exceed their emissions

[140] *New York v. EPA*, 443 F.3d 880, (D.C. Cir. 2006) concerned the use of the word "any" in a different provision in the Clean Air Act and does not lead to any different conclusion here. The Court found that the statutory language, context, and legislative intent of that provision required an expansive meaning of the phrase "any physical change" in the definition of "modification" in CAA section 111(a)(4). EPA is also applying the term "any" in an expansive manner, but in the context of a subset of motor vehicles. This takes into account the context, text, and purposes of both section 211(f)(1) and (f)(4), which, as discussed above, envisions use of such subsets of vehicles.

standards since it may not be introduced into commerce for use in any other motor vehicles or any other vehicles or engines. Thus, under a partial waiver, as the commenter suggested, all emission control devices in all the types of mobile sources listed will not be adversely impacted by the fuel. It can only be introduced into commerce for those vehicles and engines where it has been shown not to cause emissions problems; for other types of mobile sources, it cannot be introduced into commerce for use in such vehicles and engines. In concept, therefore, the combination of this partial waiver, with appropriate conditions, and partial retention of the substantially similar prohibition, has the same effect as when the criteria for a total waiver has been met–the fuel or fuel additive will only be introduced into commerce for use in a manner that will not cause violations across the fleet of motor vehicles and nonroad products. It can only be introduced into commerce for use in vehicles and engines where it has been shown not to cause violations of the emissions standards, and may not be introduced into commerce for use in other vehicles or engines.

EPA recognizes that a partial waiver raises implementation issues regarding how to ensure that a fuel or fuel additive is only introduced into commerce for use in the specified subset of motor vehicles. The discretion to grant a partial waiver includes the authority and responsibility for determining and imposing reasonable conditions that will allow for effective implementation of a partial waiver. In this case, EPA has conditioned the waiver on various actions that the fuel or fuel additive manufacturer must take. The actions are all designed to help ensure that E15 is only used by the MY2007 and later motor vehicles specified by the waiver. If a fuel or fuel additive manufacturer does not comply with the conditions, then EPA will consider their fuel or fuel additive as having been introduced into commerce for use by a broader group of vehicles and engines than is allowed under the waiver, constituting a violation of the section 211(f)(1) prohibition.

EPA recognizes, as several commenters have suggested, that EPA can impose waiver conditions only on those parties who are subject to the section 211(f)(1) prohibition and the waiver of that prohibition. These parties are the fuel and fuel additive manufacturers. Waiver conditions can apply to them, but cannot apply directly to various downstream parties, such as a retailer who is not also a fuel or fuel additive manufacturer. This is one reason EPA is also proposing specific misfueling mitigation measures in a separate rulemaking under section 211(c), to minimize any risk of misfueling. This will also facilitate compliance with certain of the waiver conditions.

Many commenters suggested that before EPA can grant a waiver of any type under section 211(f)(4), the Agency must first issue a rule under section 211(c) that addresses the proper prohibition and control of a new fuel or fuel additive to the extent necessary before such fuel or fuel additive is permitted under section 211(f)(4). However, there is no mention of timing in these two statutory provisions and EPA believes it appropriate to consider the merits of a section 211(f)(4) waiver request on its face.

B. Notice and Comment Procedures

Section 211(f)(4) requires that EPA grant or deny an application for a waiver "after public notice and comment." As discussed in detail in Section II.B., EPA published notice of receipt of the waiver application on April 21, 2009 and provided the public with an extended public comment period of 90 days to submit comments on the waiver application. EPA received approximately 78,000 comments during the public comment period.

Commenters have asked the Agency for a second public comment period so that they may review and comment on the testing data generated by the DOE Catalyst Study. An additional comment period is neither necessary nor required by law. EPA has continued to accept comments on the waiver application even after closure of the formal comment period, and has considered comments received even as late as early October. All of these comments have been included in the public docket and thus made available to all members of the public for review and comment. Many commenters have taken the opportunity to submit additional comments in light of other comments and information included in the docket.

Data from ongoing vehicle testing programs, including DOE's data, have been included in the public docket shortly after EPA has received the information, making it available for the public's review and comment as soon as practicable. Many commenters providing substantive feedback on the waiver application have been involved in one or more of the various testing programs, including DOE's, and consequently have had immediate access to the data. Comments submitted to the docket reflect that commenters have had access to and an opportunity to consider the various testing information cited by EPA in the waiver decision.

EPA has also held numerous meetings with stakeholders in which stakeholders have shared their comments, concerns and additional data regarding the waiver request. Information received at these meetings has been made available in the public docket.

In view of the access that has been made available to the relevant information in the public docket, EPA believes no need exists for a second public comment period. Moreover, EPA has already satisfied its notice and comment requirements for this Decision and has no legal obligation to provide an additional notice and comment period. EPA satisfied its procedural requirements through the public notice and comment period EPA already provided (see Section II.B) and nothing in section 211(f)(4) mandates a second comment period.[141]

C. "Useful Life" Language In Section 211(f)(4)

In making any waiver decision, section 211(f)(4) indicates that EPA should ensure that any new fuel or fuel additive will not cause or contribute to a vehicle or engine failing to meet its emissions standards over its useful life. The Clean Air Act authorizes EPA to define "useful life" for the vehicles and engines EPA regulates, *see* CAA sections 202(d) and 213(d), and EPA includes those definitions in the same regulations that contain the emission standards for those vehicles and engines.

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[141] This Decision is distinguishable from the outcome in *Air Transport Ass'n of America v. FAA*, 169 F.3d 1 (D.C. Cir. 1999). In *ATA v. FAA*, the D.C. Circuit found that the FAA's reliance on *ex parte* information submitted after closure of the public comment period violated the applicable notice and comment period requirements. The Court's holding was primarily based on the private nature of the information. *ATA*, 169 F.3d at 8 ("The important point is that because the transmission of this information…was never public, petitioner did not have a fair opportunity to comment on it."). In contrast, the data relied upon by the Agency in this waiver decision were included in the pubic docket for the decision prior to its issuance.

As discussed above, the construction of section 211(f) indicates that the meaning of section 211(f)(4) is best determined by reading it in context with the substantially similar prohibition in section 211(f)(1). Section 211(f)(1) contains the general prohibition against introducing fuels and fuel additives that are not "substantially similar" to the certification fuels used for certifying 1975 and subsequent model year motor vehicles with EPA's emissions standards. The prohibition is expansive, effectively protecting MY1975 and newer motor vehicles from using fuels or fuel additives that could detrimentally impact their ability to meet their emissions standards. In enacting this provision, Congress stated that "the intention of this new subsection [(f)] is to prevent the use of any new or recently introduced additive in those unleaded grades of gasoline required to be used in 1975 and subsequent model year automobiles which may impair emission performance of vehicles…." Senate Report (Environment and Public Works Committee) No. 95-127 (To accompany S. 252), May 10, 1977, pg 90. This general prohibition equally protects all MY1975 and newer motor vehicles from the use of new fuels and fuel additives that the motor vehicles may not have been designed to use and could degrade their emissions control systems.

The section 211(f)(1) prohibition is designed to protect the emissions control systems for the breadth of motor vehicles in the fleet, whether they are within or outside the regulatory useful life of an applicable emissions standard. This broad scope recognizes that the emissions control system of a motor vehicle continues to operate and provide important emissions benefits throughout the actual life of the motor vehicle, including the many miles or years that it may be operated past its regulatory useful life. Thus, it is important that the motor vehicle continue to use fuels that do not interfere with the continued normal operation of the emissions control system after its regulatory useful life. That normal operation may not ensure that the motor vehicle stills meets the applicable emissions standards, but it is typically such that it provides significant emissions control benefits for the country. Congress recognized this and prohibited entry into commence of fuels or fuel additives that could interfere with this result, no matter how old the motor vehicle. Congress also recognized this goal by prohibiting tampering anytime during the actual life of the motor vehicle, not just during its regulatory useful life. *See* CAA section 203(a)(3).[142]

In promulgating CAA section 211(f)(4), Congress provided EPA with the authority to waive the prohibition for particular fuels or fuel additives, but only when the fuel or fuel additive manufacturer demonstrated that motor vehicles could still meet their emissions standards while using the particular fuel or fuel additive. *See* Senate Report (Environment and Public Works Committee) No. 95-127, May 10, 1977, pg 91 ("The waiver process…was established… so that the prohibition could be waived, or conditionally waived, rapidly if the manufacturer of the additive or the fuel establishes to the satisfaction of the Administrator that the additive, whether in certain amounts or under certain conditions, will not be harmful to the performance of emission control devices or systems."). While section 211(f)(4) refers to the "useful life" of the motor vehicle, that is part of the reference to causing or contributing to the noncompliance of the motor vehicle with its emission standards, as the emissions standards are defined in part by the useful life provision. *See* House Conference Report No. 95-564 (To accompany H.R. 6161),

[142] Additionally, Congress authorized EPA to set separate in-use standards (section 202(g)) and to order recall of motor vehicles not meeting those standards (section 207(c)(1)), further illustrating its intent that emissions reductions continue at all times during the actual life of motor vehicles. Also see *General Motors Corp. v. Ruckelshaus*, 742 F.2d 1561 (D.C. Cir. 1984) (finding that section 207(c)(1) enables EPA to order a recall of all motor vehicles in a class—even those beyond their statutory useful life—as long as EPA can demonstrate that those motor vehicles were not meeting their emissions standards while within their useful life.)

Aug. 3, 1977, pp 160-162 ("The conferees also intend that the words 'cause or contribute to the failure of an emission control device or system to meet emission standards over its useful life to which it has been certified pursuant to section 206' mean the noncompliance of an engine or device with emission levels to which it was certified, taking into account the deterioration factors employed in certifying the engine.") This indicates that Congress was not trying to limit the scope of the waiver provision, but instead was using language normally used when referring to the emission standards. Congress wanted to ensure that new fuels or fuel additives allowed into the marketplace through a waiver would be the kinds of fuels or fuel additives that are consistent with motor vehicles meeting their applicable emissions standards.

In that context, EPA looks at whether the fuel or fuel additive would lead to an exceedance of the emissions standards if it was used during the motor vehicle's regulatory useful life. If that is the case, then the fuel should not be entered into commerce for use by that motor vehicle anytime during its actual life - just as the section 211(f)(1) prohibition ensures that motor vehicles will not use fuel or fuel additives anytime during their actual lives that are not substantially similar to the fuel or fuel additives used to certify their compliance with the emissions standards over their regulatory useful lives. This gives a reasonable meaning to the waiver provision and keeps it parallel and complementary to the section 211(f)(1) provision to which it is tied. EPA believes this reflects Congress' intention and avoids an unintended consequence that would be far at odds with the apparent purpose of sections 211(f)(1) and (4). If EPA were limited to only considering motor vehicles within their regulatory useful lives, this could require the Agency to approve waiver requests for new fuels and fuel additives even if they were clearly known to seriously degrade emission control devices or systems and cause large emissions increases in older motor vehicles, which comprise a significant percentage of the entire fleet. Allowing such a detrimental fuel or fuel additive into the marketplace is clearly contrary to the purposes of section 211(f) which is designed as a whole to protect the benefits of the emissions control standards over the actual life of the motor vehicles.

X. Waiver Conditions

The conditions placed upon the partial waiver EPA is granting today fall into two categories. The first category concerns properties of the ethanol used to manufacture E15 and the properties of the final E15 blend. The second category of conditions concerns mitigation of potential misfueling with E15. Any party wishing to utilize this partial waiver for E15 must satisfy all of these conditions to be able to lawfully register and introduce E15, or ethanol used to make E15, into commerce.

A. Fuel Quality Conditions

As requested by Growth Energy in their waiver request application, and as is industry practice, the partial waiver for E15 contains a condition that requires use of ethanol which meets industry specifications as outlined in ASTM International D4806[143]. Additionally, as discussed above in our evaluation of the potential effect of E15 on evaporative emissions, the partial waiver for E15 contains a condition that E15 must meet a maximum RVP of 9.0 psi during the summertime volatility season, May 1 through September 15.

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[143] ASTM International D4806-10, Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.

B. Misfueling Mitigation Conditions and Strategies

EPA believes that minimizing the possibility of misfueling of E15 into vehicles or engines for which it is not approved would best be achieved through implementation of misfueling mitigation requirements as proposed by EPA today in a separate action. Nevertheless, EPA is allowing the use of the partial waiver prior to the finalization of such requirements provided the fuel or fuel additive manufacturer using the partial waiver can implement the conditions described below prior to introducing E15 into commerce. Any fuel or fuel manufacturer wishing to utilize this partial waiver must submit a plan for EPA approval for implementing these misfueling mitigation conditions. EPA will determine if the plan is sufficient to address these conditions.

We believe that there are four important components to an effective misfueling mitigation strategy for reducing the potential for misfueling with E15. First, effective labeling is a key factor. Labeling is needed to inform consumers of the potential impacts of using E15 in vehicles and engines not approved for its use, to mitigate the potential for intentional and unintentional misfueling of these vehicles and engines. Labeling is also done at the point of sale where the consumer most likely will be choosing which fuel to use. Second, retail stations and wholesale purchaser-consumers need assurance regarding the ethanol content of the fuel that they purchase so they can direct the fuel to the appropriate storage tank and properly label their fuel pumps. The use of proper documentation in the form of PTDs has proven to be an effective means of both ensuring that retail stations know what fuel they are purchasing and as a possible defense for retail stations in cases of liability in the event of a violation of EPA standards. Third, labeling and fuel sampling surveys are necessary to ensure that retail stations are complying with labeling requirements, ethanol blenders are not blending more than the stated amount of ethanol on PTDs, and assuring downstream compliance for fuel refiners. The Agency has used this general strategy to implement several fuel programs over the past thirty years, including the unleaded gasoline program, the RFG program, and the diesel sulfur program. These strategies are conditions of use associated with today's waiver decision and are described below.

While not a condition of today's waiver decision, the fourth component of an effective misfueling mitigation strategy is effective public outreach and consumer education. Outreach to consumers and stakeholders is critical to mitigate misfueling incidents that can result in increased emissions and vehicle damage. Consumers need to be engaged through a variety of media to ensure that accurate information is conveyed to the owners and operators of vehicles and engines.

EPA recognizes that it may be difficult to fully implement all of these misfueling mitigation strategies prior to finalization of today's proposed rule. However, any fuel or fuel additive manufacturer wishing to introduce E15 into commerce before EPA finalizes its misfueling mitigation measures rule will need to demonstrate to EPA its ability to meet the following misfueling mitigation conditions of the partial waiver:

1. <u>Fuel Pump Dispenser Labeling</u>

Any fuel or fuel additive manufacturer using this partial waiver must ensure the labeling of any dispensers of this gasoline-ethanol blend. The label would have to indicate that the fuel contains up to 15 vol% ethanol – that is, the fuel is gasoline containing greater than 10 vol% ethanol and up to 15 vol% ethanol.

Based on the Agency's experience with fuel pump labeling for Ultra-Low Sulfur Diesel (ULSD) and Low Sulfur Diesel (LSD) (see 40 CFR §80.570), there are four important elements to an effective label for misfueling. The language of the E15 label must contain four components: (1) an information component; (2) a legal approval component; (3) a technical warning component; and (4) a legal warning component. Together, these four components highlight the critical information necessary to inform consumers about the impacts of using E15.

The labeling requirements EPA is proposing today in a separate proposed rule concurrent with today's partial waiver decision would place labeling requirements on retail stations that dispense E15. Compliance with these labeling requirements, when finalized, will satisfy this fuel pump dispenser labeling condition. If a fuel or fuel additive manufacturer chooses to utilize this partial waiver prior to finalization of today's proposed rule, a label designed to meet the components described in today's proposed rule and approved by EPA can satisfy this fuel pump dispenser labeling condition of this partial waiver decision.

2. <u>Fuel Pump Labeling and Fuel Sample Survey</u>

Any fuel or fuel additive manufacturer using this partial waiver must participate in a survey, approved by EPA, of compliance at fuel retail facilities conducted by an independent surveyor. An EPA-approved survey plan is to be in place prior to introduction of E15 into the marketplace and the results of the survey must be provided to EPA for use in its enforcement and compliance assurance activities.

One of two options may be utilized to meet this condition of this partial waiver decision:

For Survey Option 1, a fuel or fuel additive manufacturer may individually survey labels and ethanol content at retail stations wherever its gasoline, ethanol, or ethanol blend may be distributed if it may be blended as E15. EPA must approve this survey plan before it is conducted by the fuel or fuel additive manufacturer.

For Survey Option 2, a fuel or fuel additive manufacturer may choose to conduct the survey through a nationwide program of sampling and testing designed to provide oversight of all retail stations that sell gasoline. Details of the survey requirements are similar to those included in the ULSD and RFG programs. A fuel or fuel additive manufacturer may conduct this survey as part of a consortium, as discussed in the proposed rule.

EPA is proposing more formal requirements for a national E15 labeling and ethanol content survey in today's notice of proposed rulemaking. If a fuel or fuel additive manufacturer chooses to utilize this partial waiver prior to finalization of today's proposed rule, a survey designed to satisfy the components described in today's proposed rule and approved by EPA will be deemed to be sufficient to satisfy this fuel pump labeling and fuel sample survey condition of this partial waiver decision.

3. Proper Documentation of Ethanol Content on Product Transfer Documents

Today's proposed rule would require that parties that transfer blendstocks, base gasoline for oxygenate blending, and/or finished gasoline that contains ethanol content greater than 10 vol% and no more than 15 vol% include the ethanol concentration of the fuel in volume percent. Product transfer documents (PTDs) are customarily generated and used in the course of business and are familiar to parties who transfer or receive blendstocks or base gasoline for oxygenate blending and oxygenated gasoline. Since we are approving a partial waiver for the introduction into commerce of E15 for use in only MY2007 and newer motor vehicles, the PTDs that accompany the transfer of base gasoline/gasoline blendstocks used for oxygenate blending and for oxygenated gasoline must include the ethanol content of the fuel to help avoid misfueling. Downstream of the terminal where ethanol blending takes place, information on the maximum ethanol concentration in the ethanol blend is needed to help ensure that fuel shipments are delivered into the appropriate storage tanks at retail and fleet gasoline dispensing facilities.[144] A gasoline retail station and fleet dispensing facility must know the ethanol content of a fuel shipment so that fuel pumps may be correctly labeled.

[144] Evaluations are underway which may facilitate the shipment of gasoline-ethanol blends by pipeline to terminals. Hence, parties upstream of the terminal may need to include information on maximum ethanol concentration on product PTDs in the future.

In the event that there is a period of time when this partial waiver is utilized prior to finalization of today's proposal, a PTD program designed to satisfy the elements of today's proposed rule will be sufficient to satisfy the PTD condition of this partial waiver decision.

4. <u>Public Outreach</u>

While not a formal condition of this partial waiver, EPA recognizes the importance of outreach to consumers and stakeholders to misfueling mitigation. The potential for E15 misfueling incidents may exist for several reasons. For example, consumers may be inclined to misfuel when E15 costs less than E10 or E0. Additionally, in some situations, it may be more difficult to find fuels other than E15. EPA thus encourages fuel and fuel additive manufacturers to conduct a public outreach and education program prior to any introduction of E15 into commerce.

A recent example of outreach to consumers and stakeholders that may be applicable is coordinated work done in support of the ULSD program. ULSD was a new fuel with the possibility of consumer misfueling that could result in engine damage. With ULSD, the fuel industry trade association API took the lead in working with stakeholders to establish the Clean Diesel Fuel Alliance (CDFA), a collaboration of public and private organizations designed to ensure a smooth program transition by providing comprehensive information and technical coordination. The organizations represented in the CDFA include engine manufacturers, fuel retailers, trucking fleets, DOE and EPA. CDFA efforts to educate ULSD users include developing technical guidance and educational information, including a web site (www.clean-diesel.org), as well as serving as a central point of contact to address ULSD-related questions.

The CDFA outreach model could prove beneficial in this case. EPA anticipates that all parties involved in bringing higher gasoline-ethanol blends to market will participate in a coordinated industry-led consumer education and outreach effort. In the context of this program, potential key participants include ethanol producers, fuel and fuel additive manufacturers, automobile, engine and equipment manufacturers, states, non-governmental organizations, parties in the fuel distribution system, EPA, DOE, and USDA. Potential education and outreach activities a public/private group could undertake include serving as a central clearinghouse for technical questions about E15 and its use, promoting best practices to educate consumers or mitigate misfueling instances, and developing education materials and making them available to the public.

XI. Reid Vapor Pressure

Commenters questioned whether E15 would qualify for the 1.0 psi RVP waiver permitted for E10 under CAA section 211(h). As explained in the misfueling mitigation measures proposed rule, EPA interprets the 1.0 psi waiver in CAA section 211(h) as being limited to gasoline-ethanol blends that contain 10 vol% ethanol. Please see the preamble of that proposed rule for more discussion of this issue and for an opportunity to submit comments on this issue.

XII. Partial Waiver Decision and Conditions

Based on all the data and information described above, EPA has determined that, subject to compliance with all of the conditions below, a gasoline produced with greater than 10 vol% and no more than 15 vol% ethanol (E15) will not cause or contribute to a failure of certain motor vehicles to achieve compliance with their emission standards to which they have been certified over their useful lives.

Therefore, the waiver request application submitted by Growth Energy for its gasoline-ethanol blend with up to 15 vol% ethanol is partially and conditionally granted as follows:

(1) The partial waiver applies only to fuels or fuel additives introduced into commerce for use in MY2007 and newer light-duty motor vehicles, light-duty trucks, and medium duty passenger vehicles (hereafter "MY2007 and newer light-duty motor vehicles") as certified under Section 206 of the Act. The waiver does not apply to fuels or fuel additives introduced into commerce for use in pre-MY2007 motor vehicles, heavy-duty gasoline engines or vehicles, or motorcycles certified under section 206 of the Act, or any nonroad engines, nonroad vehicles, or motorcycles certified under section 213(a) of the Act.

(2) The waiver applies to the blending of greater than 10 vol% and no more than 15 vol% anhydrous ethanol into gasoline[145], and the ethanol must meet the specifications for fuel ethanol found in the ASTM International specification D4806-10[146].

[145] Gasoline in this case may be gasoline blendstocks that produce gasoline upon the addition of the specified amount of ethanol covered by the waiver.
[146] ASTM D4806-10, Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.

(3) The final fuel must have a Reid Vapor Pressure not in excess of 9.0 psi during the time period from May 1 to September 15.

(4) Fuel and fuel additive manufacturers subject to this partial waiver must submit to EPA a plan, for EPA's approval, and must fully implement that EPA-approved plan, prior to introduction of the fuel or fuel additive into commerce as appropriate. The plan must include provisions that will implement all reasonable precautions for ensuring that the fuel or fuel additive (i.e. gasoline intended for use in E15, ethanol intended for use in E15, or final E15 blend) is only introduced into commerce for use in MY2007 and newer motor vehicles. The plan must be sent to the following address: Director, Compliance and Innovative Strategies Division, U.S. Environmental Protection Agency, 1200 Pennsylvania Ave., N.W. Mail Code 6405J, Washington, D.C. 20460. Reasonable precautions in a plan must include, but are not limited to, the following conditions on this partial waiver:

(a)(i) Reasonable measures for ensuring that any retail fuel pump dispensers that are dispensing a gasoline produced with greater than 10 vol% ethanol and no more than 15 vol% ethanol are clearly labeled for ensuring that consumers do not misfuel the waivered gasoline-ethanol blend into vehicles or engines not covered by the waiver. The label shall convey the following information:

(A) The fuel being dispensed contains 15% ethanol maximum;

(B) The fuel is for use in only MY2007 and newer gasoline cars, MY2007 and newer light-duty trucks and all flex-fuel vehicles;

(C) Federal law prohibits the use of the fuel in other vehicles and engines; and

(D) Using E15 in vehicles and engines not approved for use might damage those vehicles and engines.

(ii) The fuel or fuel additive manufacturer must submit the label it intends to use for EPA approval prior to its use on any fuel pump dispenser.

(b) Reasonable measures for ensuring that product transfer documents accompanying the shipment of a gasoline produced with greater than 10 vol% ethanol and no more than 15 vol% ethanol properly document the volume of ethanol.

(c)(i) Participation in a survey of compliance at fuel retail dispensing facilities. The fuel or fuel additive manufacturer must submit a statistically sound survey plan to EPA for its approval and begin implementing the survey plan prior to the introduction of E15 into the marketplace. The results of the survey must be provided to EPA.[147] The fuel or fuel additive manufacturer conducting a survey may choose from either of the following two options:

(ii) Individual survey option: Conduct a survey of labels and ethanol content at retail stations wherever your gasoline, ethanol, or ethanol blend may be distributed if it may be blended as E15. The survey plan must be approved by EPA prior to conducting the survey plan.

(iii) Nationwide survey option: Contract with an individual survey organization to perform a nationwide survey program of sampling and testing designed to provide oversight of all retail stations that sell gasoline. The survey plan must be approved by EPA prior to conducting the survey plan.

[147] In a Notice of Proposed Rulemaking published in today's Federal Register (cite), EPA is proposing a more detailed labeling, product transfer documents, and survey plan.

(d) Any other reasonable measures EPA determines are appropriate.

(5) Failure to fully implement any condition of this partial waiver means the fuel or fuel additive introduced into commerce is not covered by this partial wavier.

This partial waiver decision is final agency action of national applicability for purposes of section 307(b)(1) of the Act. Pursuant to CAA section 307(b)(1), judicial review of this final agency action may be sought only in the United States Court of Appeals for the District of Columbia Circuit. Petitions for review must be filed by [INSERT DATE 60 DAYS AFTER PUBLICATION]. Judicial review of this final agency action may not be obtained in subsequent proceedings, pursuant to CAA section 307(b)(2). This action is not a rulemaking and is not subject to the various statutory and other provisions applicable to a rulemaking.

Dated: ______________________

Lisa P. Jackson,

Administrator.